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WESTERN LAKE ERIE SHORE STUDY, OHIO. RECONNAISSANCE REPORT (STA--ETC(U)
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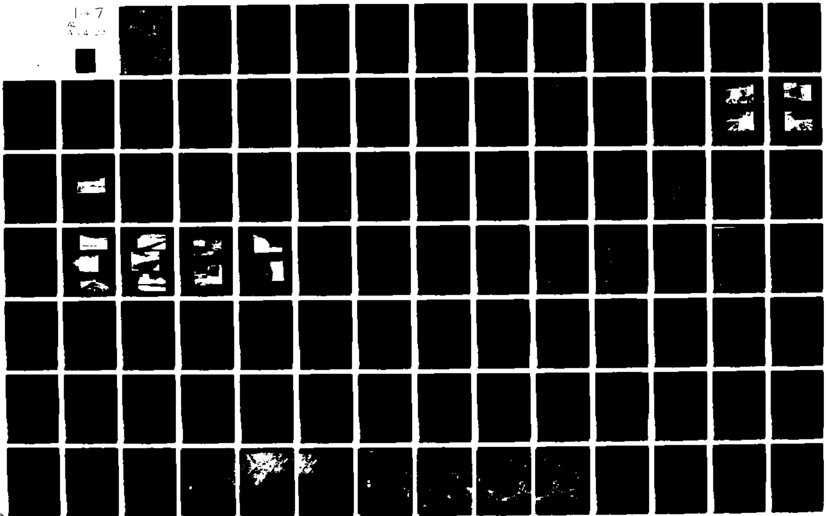

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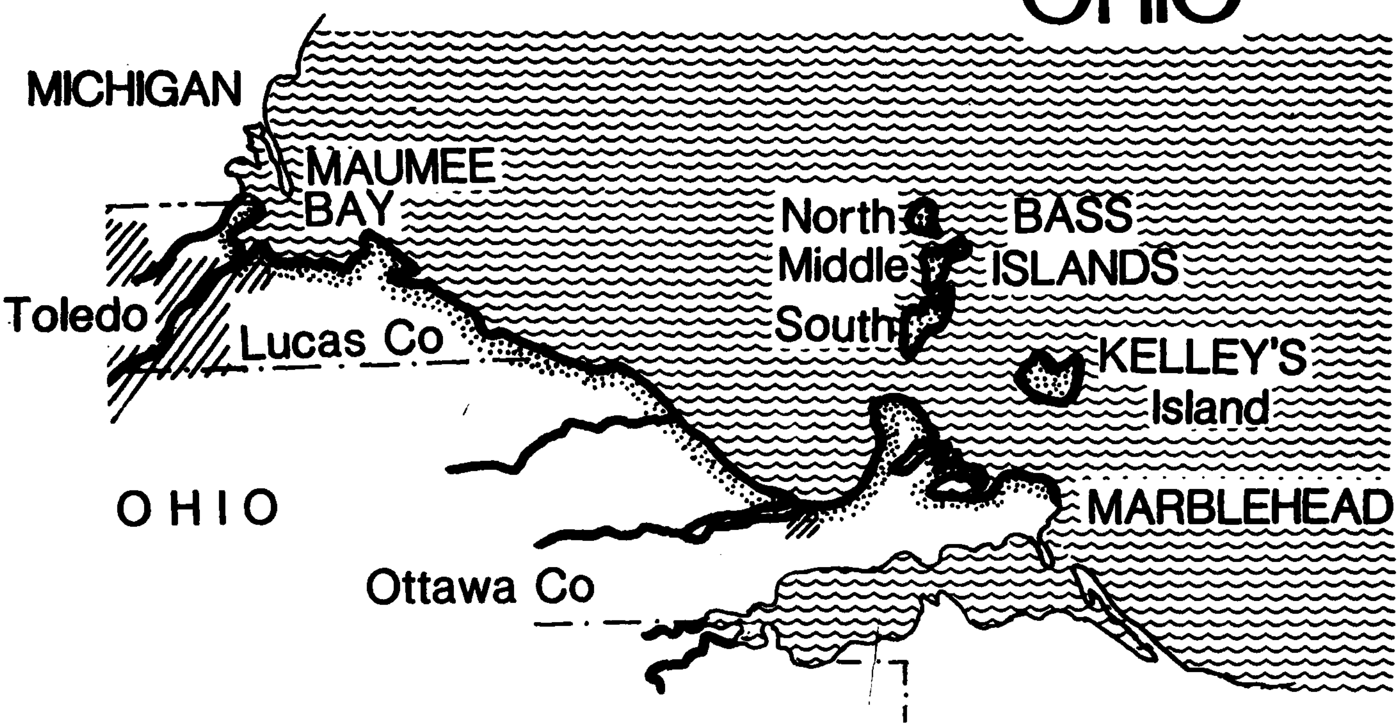

RECONNAISSANCE REPORT (STAGE I) ON FLOOD PROTECTION AND SHORELINE EROSION CONTROL

U.S. ARMY CORPS OF ENGINEERS
BUFFALO DISTRICT
1776 NIAGARA STREET
BUFFALO, NEW YORK 14207

APRIL 1981
(REVISED JUNE 1981)

Unclassified

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Beach Erosion Control
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Ohio

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

The study investigated the need for and viability of providing effective and economical means of arresting beach and shore erosion and reducing flood damages along the Ohio Shore of Lake Erie between the Michigan-Ohio State line and Marblehead, Ohio. Approximately twelve areas which have experienced flooding were identified. None were recommended for further study because damages experienced were insufficient to offset anticipated construction costs.

Four areas were identified which had experienced shoreline or beach erosion. Of these, two were eliminated for lack of economic justification and two were

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recommended for further study. These two, both State owned Parks, are at Maumee Bay and East Harbor. Feasibility Studies are currently underway to determine ways to reestablish beaches and protect the shorelines at these two locations against future erosion.

WESTERN LAKE ERIE, OHIO
RECONNAISSANCE REPORT (STAGE 1)

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ACKNOWLEDGEMENTS

This Reconnaissance Report on the Western Lake Erie Shore Study (WLES) was prepared through the efforts of many individuals on the Interdisciplinary Team in the Buffalo District with significant input from personnel of other agencies. The Main Report was written for the most part, by John Zorich. Study management was initially performed by James De LaPlante, by Anthony Eelman on an interim basis, and by Richard Mammoser in the final stages. Other Buffalo District staff who contributed significantly included: Albert T. Fulco, Hydraulic Engineer, who performed the flood damage analysis and related hydraulic investigations; Arthur Redenbach, Civil Engineering Technician, who with assistance from Raymond Lewis and Salvatore Nobile performed the flood damage surveys; Sharon Cooper, Economist, who performed the economic analysis; and William Butler, Social Scientist who provided much of the environmental input. Other District personnel who were involved in this study are:

Joan Pope - Coastal Geologist
Richard Gorecki - Coastal Engineer
Darlene Rowen - Civil Engineer
Richard Lewis - Archaelogist
Leonard Kotkiewicz - Estimator
John Adams - Chemist

Individuals from other agencies who were significant contributors to the study effort include:

Diana Hwang, Biologist - U. S. Fish & Wildlife Service
George Wilson, County Engineer - Lucas County
John Papcun, County Engineer - Ottawa County

Numerous others were involved and contributed to this report through participation in workshops and individual decisions with Buffalo District staff. These individuals are not easily indentified, so recognition is provided by the names of their employing agencies, as follows:

U. S. Fish and Wildlife Service, Columbus, OH Field Office
U. S. Department of Agriculture, Soil Conservation Service
Ohio Department of Natural Resources

The report itself was produced throught the efforts of many other District personnel, who contributed significantly to its preparation:

Roman Bartz - Chief, Drafting Section
Irving Stone - Lead Draftsman
John Acker - Draftsman
Richard Greene - Draftsman
Mary Hamilton - Draftsman
Gary Smith - Draftsman

Word Processing Staff

Freda T. Soper - Chief,
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Linda A. Jones
Mary Ann Lewecki
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Susan Ward

Reproduction Branch

George Key, - Chief
Harold Sokody

During this Stage 1 investigation for the Western Lake Erie Shore Study, Colonel George P. Johnson was District Engineer, the Chief of Engineering Division was Donald M. Liddell, and the Chief of Planning Branch was Charles E. Gilbert.

Finally, the efforts of other individuals who participated in the study and report preparation but whose names have not been mentioned above, are gratefully acknowledged.

SECTION A
INTRODUCTION

Shore erosion and flooding are major water resource problems along the shoreline of the Great Lakes. Millions of dollars in property loss and damage have been suffered by both public shoreline facilities and private shoreline property interests along the Great Lakes due to erosion and flood inundation.

The water levels of the Great Lakes fluctuate on long-term, seasonal, and short-term bases. Noncyclical extended periods of above average precipitation produce above average levels on the Lakes. Short-term fluctuations in Lake levels are caused by winds and/or pressure differentials on the lake surfaces. These conditions, in combination, are the principal causes of shore erosion and flooding problems along the Great Lakes.

The area under study encompasses about 60 miles of the Ohio shore of Lake Erie and offshore islands within Lucas and Ottawa Counties, extending from the Ohio - Michigan State line on the west to approximately Marblehead, Ohio on the east. Kelley's Island, located in Erie County is also included in the study. The study area is shown on Figure A1, following.

This Reconnaissance Report (Stage 1 document) identifies the shoreline erosion, flood inundation and related water resources problems and needs in the study area; presents the results of preliminary engineering, economic and environmental analysis and assesment; and recommends future courses of action for proceeding toward project implementation in carrying out the directives of the Congressional resolution authorizing the Western Lake Erie Shore Feasibility Study.

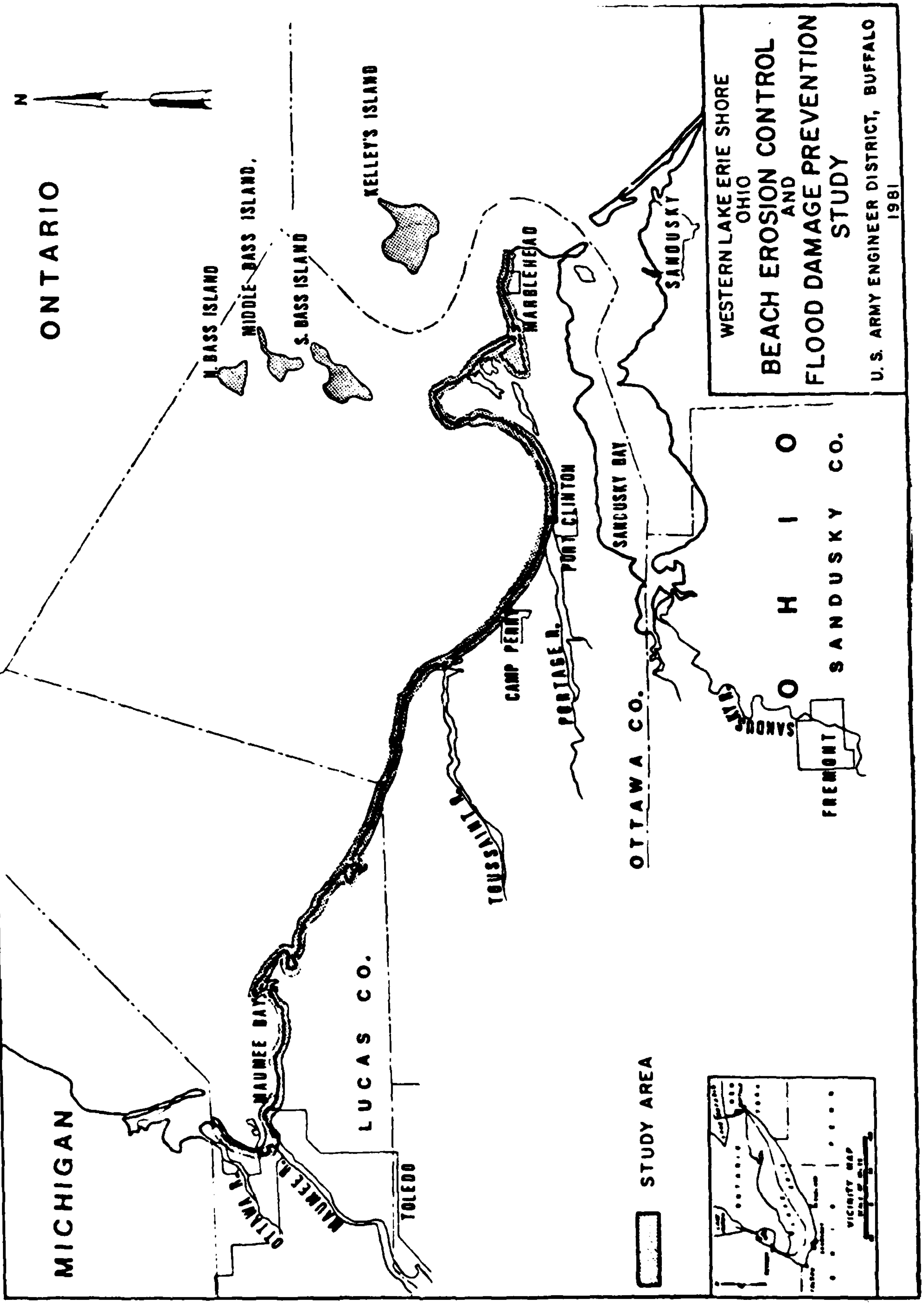

WESTERN LAKE ERIE SHORE
OHIO
BEACH EROSION CONTROL
AND
FLOOD DAMAGE PREVENTION
STUDY
U.S. ARMY ENGINEER DISTRICT, BUFFALO
1981
ONTARIO
MICHIGAN
OHIO
N
N. BASS ISLAND
MIDDLE BASS ISLAND
S. BASS ISLAND
KELLEY'S ISLAND
MARBLEHEAD
SANDUSKY
SANDUSKY BAY
PORT CLINTON
CAMP PERRY
PORTAGE R.
TOUSSAINT R.
OTTAWA CO.
SANDUSKY CO.
SANDUSKY R.
FREMONT
LUCAS CO.
MAUMEE BAY
MAUMEE R.
OTTAWA R.
TOLEDO
STUDY AREA
VICINITY MAP

FIGURE A1

STUDY AUTHORITY

The authority for this feasibility study was provided by resolution of the Committee on Public Works of the U. S. House of Representatives on 11 April 1974. Specifically, the resolution states:

> "Resolved by the Committee on Public Works of the House of Representatives, United States, that the Board of Engineers for Rivers and Harbors is hereby requested to review the report, Lake Erie Shore Line from the Michigan - Ohio State Line to Marblehead, Ohio, published as House Document Number 63, 87th Congress, 1st Session, and other pertinent reports, with a view to determining the advisability of providing for beach erosion control, flood protection and related purposes in the study area, with particular reference to the advisability of protection work against storm waves and wind generated high lake levels."

The study was assigned by the Office, Chief of Engineers, to the North Central Division. In turn it was assigned to the District Engineer, Detroit District. With the realignment of the Buffalo - Detroit District boundaries in early 1978, the study was then reassigned to the District Engineer, Buffalo District. Funds to initiate this study - entitled "Western Lake Erie Shore, Ohio" - were provided to Buffalo District in Fiscal Year 1979.

Study Purpose and District Interpretation of Study Authority

The primary purpose of the Western Lake Erie Shore Feasibility Study is to determine the need for and viability of providing effective and economical means of arresting beach and shore erosion and reducing flood damages along the Ohio shore of Lake Erie between the Ohio - Michigan State line and Marblehead, Ohio. With regards to beach and shore erosion, particular emphasis is placed on improvements for public-owned properties. Consistent with the directives of the Study Resolution, protection against storm waves and wind-generated high lake levels will be emphasized. In addition to erosion and flooding problems, other related water resources problems and needs such as navigation, recreation, and water quality will be identified, addressed and recommended courses of future action presented.

Based on the District's interpretation of the authorizing resolution, and review of the survey report published in House Document No. 63, 87th Congress, 1st Session (1961), the study area is limited to those lands affected by the levels of Lake Erie. Therefore, except for low-lying inland areas subject to inundation from high Lake Erie levels, the study shall involve the water resources problems along a relatively narrow strip of shoreline immediately contiguous to Lake Erie.

In addition to reviewing the problem areas identified in prior reports, strong consideration is given to the views of involved State, regional, county, and local agencies and officials in identifying other problem areas. A public involvement program - consisting of public meetings, agency workshops, interviews with officials and individuals and joint site inspections - was established to aid in this effort.

SCOPE OF THE STUDY

The study area encompasses the Ohio shoreline of Lake Erie in Lucas and Ottawa counties from the Ohio - Michigan border eastward to about Marblehead, Ohio, a distance of approximately 60 shoreline miles. Included in the study area are the Bass Island Chain and Catawba Island in Ottawa County, and Kelley's Island in Erie County. The locality is shown on Figure A1, and also on: U. S. Lake Survey Charts No. 14830, 14842, 14844, 14846, and 14847; and the Oregon, Reno Beach, Metzger Marsh, Oak Harbor, Lacarne, Port Clinton, Put-in-Bay, Gypsum, and Kelley's Island U. S. Geologic Survey 7-1/2 minute quadrangle maps.

The scope and breadth of the study will be conducted with full consideration of the limitations on Corps implementation of various measures. Thus, those alternative plans which can be authorized as a direct result of this study will be considered in greater detail than those requiring additional implementing authority or implementation by others. This is not to say that plans nonimplementable by the Corps under this study authority will receive lesser attention when developing alternative plans. An example of a water resource project that cannot be implemented by the Corps is protection of privately owned shoreline properties against erosion. Thus, less emphasis will be placed on developing alternative plans for this type of property than on protecting public lands for which protective works can be constructed and cost-shared by the Corps.

STUDY PARTICIPANTS AND COORDINATION

Principal Study Participants

An interdisciplinary team of Buffalo District staff was utilized for this initial Stage 1 Reconnaissance Study. In addition, personnel from the U. S. Fish and Wildlife Service, U. S. Soil Conservation Service, Ohio Department of Natural Resources, County Engineers for Lucas and Ottawa Counties, and officials of several local governments have provided valuable input in identifying water resource problems and needs in the study area.

Coordination and Public Involvement

Initiation of this feasibility study was announced by a Buffalo District news release dated 28 November 1978. A copy of the news release is provided as Exhibit G1 of Appendix G to this Reconnaissance Report.

Orientation Workshops were held on 10 and 11 January 1979 in Lucas and Ottawa Counties, respectively. The purposes of these workshops were (1) to inform principal non-Corps interests of study initiation, the primary study purposes (i.e. - shoreline/beach erosion and flood damage prevention), and the study process and contemplated schedule; and (2) to solicit local interests views on water resources problems and needs within the 60-mile reach of Lake Erie shoreline between the Michigan - Ohio Line and Marblehead, Ohio. Exhibit G2 of Appendix G is the Information Packet that was sent to the study participants prior to the workshops. Exhibits G3 and G4 of Appendix G are the

Summary Minutes for the 10 and 11 January 1979 workshops held in Lucas and Ottawa Counties, respectively.

As a result of these two workshops, a number of individual problem areas were identified by local interests. Pertinent correspondence on these problem areas is included as Exhibit H1 of Appendix H to this Plan of Study.

In response to the water resource problems and needs and specific problem areas identified by local interests at the workshops, and through correspondence and interviews, onsite reconnaissances of the area were conducted by Buffalo District staff. Trip reports for the reconnaissances of 2-5 October 1978, 6-8 November 1979, 8-10 January 1980, and 21-23 January 1981, are provided as Exhibits G5 through G8 of Appendix G, respectively. These site reconnaissances, supplemented by information provided by local officials and individuals through correspondence and interviews, were instrumental in the District's conclusions regarding the need and/or the applicability of further, more detailed studies for many of the problem areas identified.

The Public Involvement and Coordination Programs will be continued throughout Stages 2 and 3 of this feasibility study. These activities will include public meetings early in Stage 2 and late in Stage 3, information and technical workshops as appropriate, and discussions with individual local, county, and State officials and private citizens, as required. An example of the continued coordination is a series of technical workshops that was held with representatives of the Ohio Department of Natural Resources (ODNR) and U. S. Fish and Wildlife Service during Stage 2 of the Maumee Bay State Park Erosion Study which is being conducted by Buffalo District as an Interim Study under this Western Lake Erie Shore Study.

OTHER RELATED STUDIES

Numerous other studies have been conducted, and reports prepared, for the 60-mile reach of Lake Erie shoreline covered by this study authorization. These studies - some of which led to project implementation by agencies of various levels of government - include water resources development in the interest of commercial and recreational navigation, flood damage reduction, shoreline and beach erosion, and general recreation. Programs in these areas have developed as a result of the resource's impact upon man and his desire for development. Other programs, such as the establishment and management of wildlife areas and the Coastal Zone Management Program, strive to provide a mutually beneficial balance between man and his natural environment, and to strive to understand his impact on the water and related land resources.

The following is a listing of studies/programs that are either directly or indirectly related to the Western Lake Erie Shore Feasibility Study. Specifics on these studies/projects are discussed in detail in Section B, "Problem Identification," of this Reconnaissance Report. A bibliography of other pertinent studies/programs is provided in Appendix I to this report.

U. S. Army Corps of Engineers Programs or Studies

- Toledo Harbor, Ohio, Commercial Navigation Project

- Point Place, Ohio, Flood Control Project
- Reno Beach/Howard Farms, Ohio, Flood Control Project
- West Harbor, Ohio, Small-Boat Harbor Project
- Port Clinton, Ohio, Small-Boat Harbor Project
- "Operation Foresight" Emergency Flood Control Project (1973-1974).
- Great Lakes Shoreline Damage Survey (1979)
- Beach Erosion Study, Ohio/Michigan Line to Marblehead, Ohio (HD 177, 79th Congress, 1945)
- Beach Erosion Control Study, Ohio/Michigan Line to Marblehead, Ohio (HD 63, 87th Congress, 1961)
- Great Lakes Region Inventory Report, National Shoreline Study (1971)

Programs/Studies of Other Agencies

- Great Lakes Basin Framework Study
- Great Lakes Basin Plan
- International Lake Erie Regulation Study
- Regulation of Great Lakes Water Levels
- State of Ohio Coastal Zone Management Program
- Lake Erie Wastewater Management Study
- Lake Erie Shore Erosion and Flooding, Lucas County Ohio, (ODNR, 1978)

THE REPORT AND STUDY PROCESS

The overall organization of this Reconnaissance Report consists of a Main Report and a series of technical appendices. The Main Report summarizes the Reconnaissance Study activities and is written to give both the general and technical reader a clear understanding of the study, and its outcome without delving into technical details. The Appendices are provided to present more detailed information on specific topics for those interested readers. The Appendices which are part of this report are as follows:

Appendix A - Hydraulic Design and Hydrology
Appendix B - Economics Studies
Appendix C - Coastal Engineering Studies and Preliminary Designs
Appendix D - Quantity and Cost Estimates
Appendix E - Fish and Wildlife Report
Appendix F - PB-6
Appendix G - Public Involvement
Appendix H - Correspondence
Appendix I - Bibliography of Studies/Programs
Appendix J - Study Flow Network

This Western Lake Erie Shore Feasibility Study is being conducted in accordance with the guidelines set forth by the Water Resources Council's Principles and Standards for Planning Water and Related Land Resources (P&S) established in 1973 and revised 29 September 1980, and supplemented by the planning process requirements of the Office of the Chief of Engineers (OCE) as established in the "200 Series" Engineering Regulations. In addition, this feasibility study will utilize the multiobjective planning framework

established by OCE, and published in the Code of Federal Regulations, Title 33, Part 290. This framework, also in the form of Corps regulations, sets forth guidance consistent with the stated requirements of P&S.

This planning process involves three separate stages of plan development as shown in Figure A2, following: Stage 1 - development of the Reconnaissance Report; Stage 2 - development of intermediate plans; and Stage 3 - development of the detailed plans. Within each stage of plan development, four functional planning tasks - problem identification, formulation of alternatives, impact assessment, and evaluation - are performed. Through the iterative process performed within each stage, and increased specificity of plan development from a given stage to the next higher ordered stage, the ultimate identification and selection of the "best plan-of-action" is obtained.

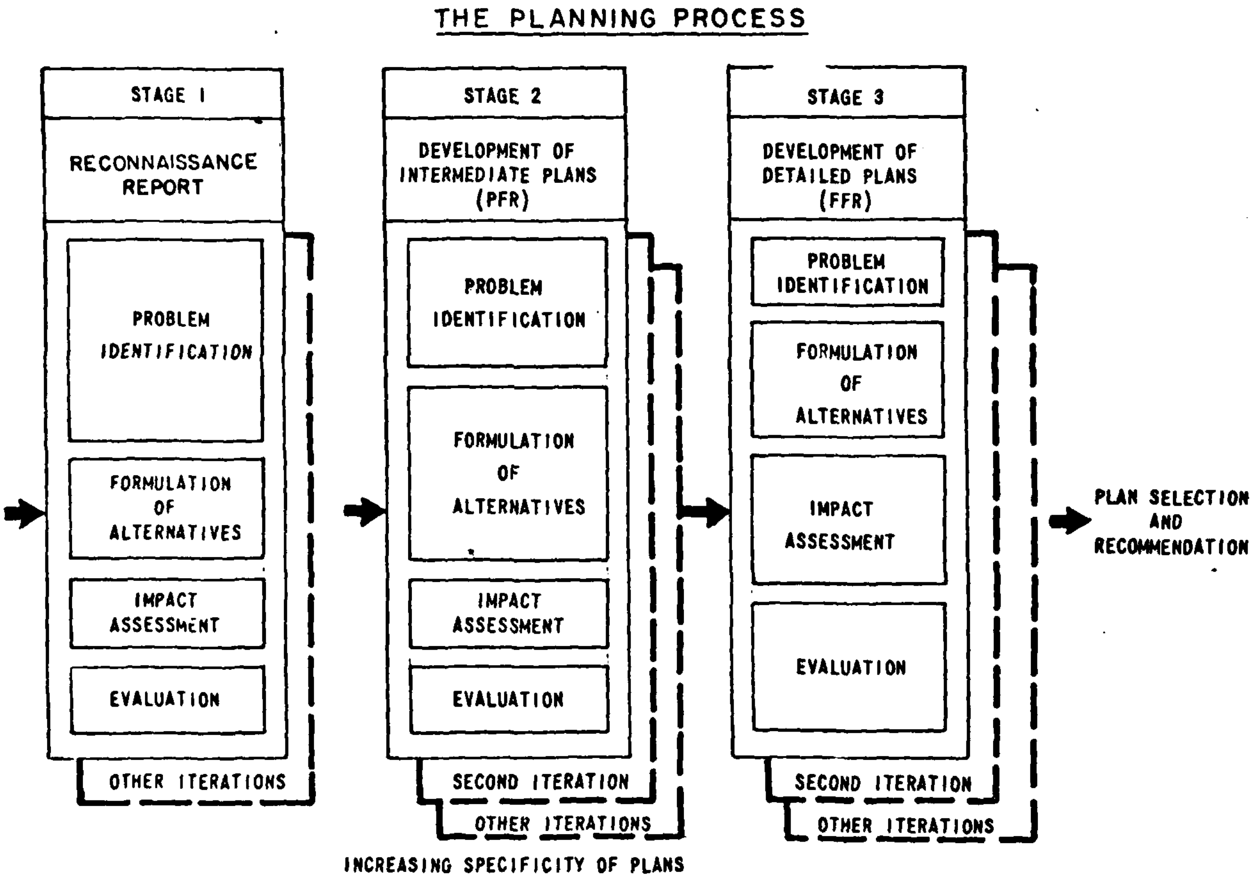


Figure A2 - Planning Process

An interdisciplinary team, consisting of water resource and recreational planners, engineers, economists, biologists, socialogists, hydrologists, and other disciplines, is needed to perform the specialized tasks involved in

this process. The District has used and will continue to use, this interdisciplinary approach in conducting this study. District human resources will be supplemented by the services of Architect/Engineer firms and Interagency Agreements with other Federal agencies such as the U. S. Fish and Wildlife Service, as needed.

The results of each stage of study development will be documented in a report prepared at the end of each stage. These reports will be furnished to other agencies and the public for review and comments and also serve as internal management and decision documents within the Corps of Engineers.

This Reconnaissance Report reflects the results of Stage 1 of the study process. It sets forth the justification for the feasibility study, documents the findings of the tasks performed to date, establishes a program for managing the study, and provides a first approximation of the schedule of activities through completion of Stage 3. It is also the basis for approval, by higher authority, of completed and future study efforts.

The results of Stage 2 planning will be presented in the Preliminary Feasibility Report (PFR) and Stage 3 planning in the Final Feasibility Report (FFR). These reports will present the development of plans, and an assessment and evaluation of their respective impacts. As noted previously, the specificity of the reports increases in subsequent stages. The FFR and its recommendations is reviewed by the North Central Division of the Corps, the Board of Engineers for Rivers and Harbors, the Office of the Chief of Engineers, the Governor of the State of Ohio, Secretaries of the various prescribed Federal agencies, the Secretary of the Army, the Water Resources Council, the Office of Management and Budget, and finally, the Congress.

The District is concurrently preparing an Interim Report on Shoreline Erosion and Beach Restoration at Maumee Bay State Park, Ohio under the Western Lake Erie Shore study authorization. Approval to conduct this interim study at Maumee Bay State Park was provided by higher headquarters in November 1978. A Reconnaissance Report prepared in November 1976 under the authority of Section 103(a)of the River and Harbor Act of 1962, as amended, was used as the basis for proceeding with Stage 2 of the Maumee Bay State Park Interim. The Preliminary Feasibility Report for the Maumee Bay State Park Interim, dated September 1980, is currently (March 1981) being revised by Buffalo District and will be distributed to the public in Spring 1981. Stage 3 for this Interim Study will be performed in conformance with the planning process outlined above. Figure A3, following, is a bar chart showing the general relationship of the Maumee Bay Interim to the overall Western Lake Erie Shore Feasibility Study.

SEQUENCE OF MAJOR ACTIVITIES FOR WESTERN LAKE ERIE SHORE, OHIO AND MAUMEE BAY STATE PARK INTERIM

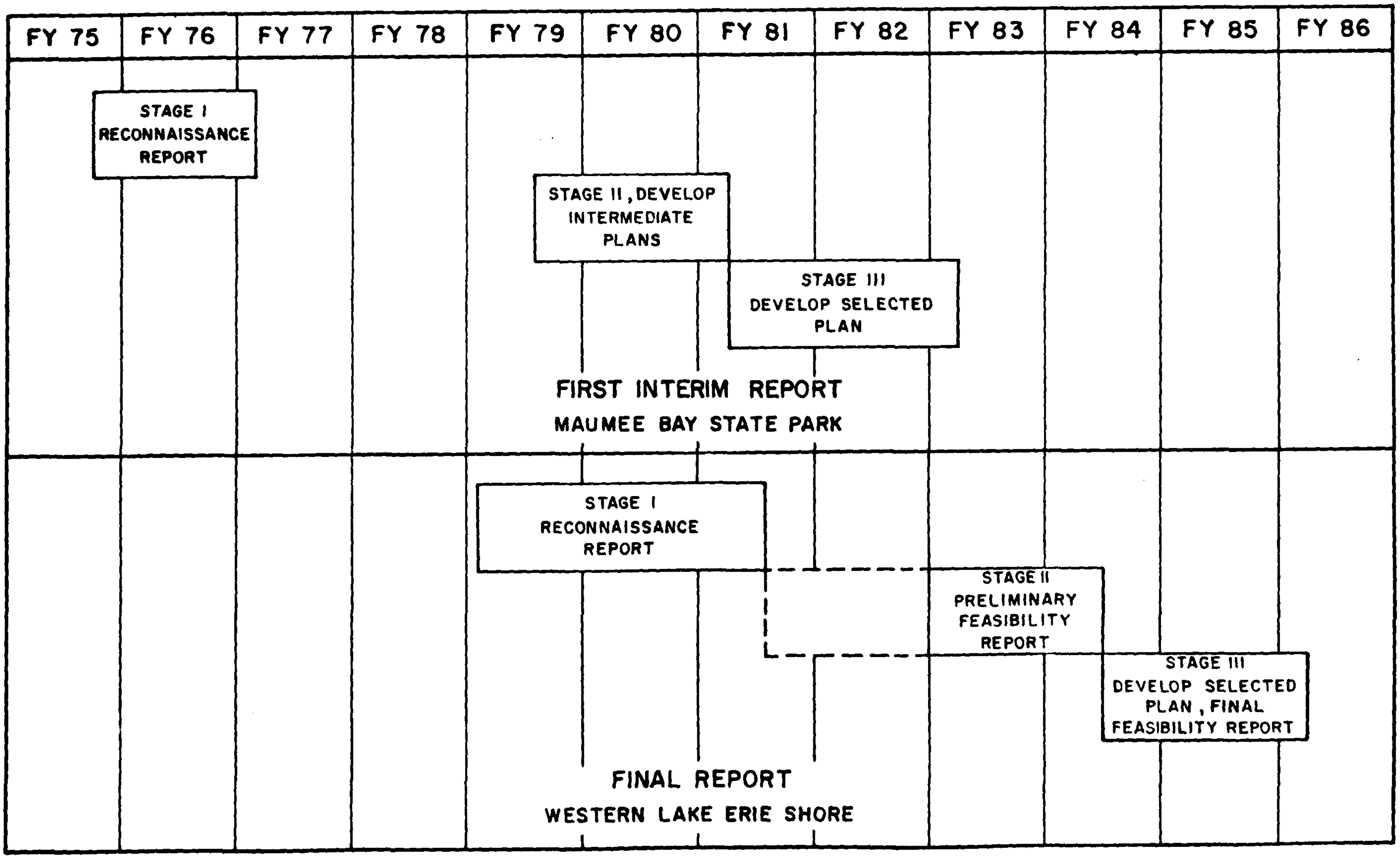


FIGURE A3

SECTION B
PROBLEM IDENTIFICATION

Problem identification is the initial task to be performed in each stage of a feasibility study. It is of primary importance in preparing the Reconnaissance Report (Stage 1). Thus, the major emphasis of this Reconnaissance Report on the Western Lake Erie Shore feasibility study is to identify the full range of water and related land resources problems and needs along the 60-mile shoreline of Lake Erie between the Michigan-Ohio line and Marblehead, Ohio (see Figure A1 of Section A for study area). Consistent with the directives of the authorizing resolution, the shoreline erosion and flood inundation problems in the study area are stressed. However, other problems and needs are identified and addressed in conformance with current Corps policy requiring multi-objective planning for water resources development. Once the specific problems have been identified, the planning objectives for the study area can be determined, and the formulation of alternatives can proceed. Specifically, problem identification involves identifying public concerns, analyzing resource management problems to identify the specific problem area, describing the base condition, projecting future conditions, and finally establishing the planning objectives specific to the study area. This process is guided by the national policy for water resource planning as established by the Water Resources Council (WRC). The policy states that Federal and Federally assisted water and related land management activities be planned toward achieving National Economic Development (NED) and Environmental Quality (EQ).

The purposes of this section are: to acquaint the reader with the study area encompassing the 60-mile reach of Lake Erie shoreline between the Michigan-Ohio line and Marblehead, Ohio; to define the national objectives; to identify the public concerns; to describe the existing conditions and conditions that will exist if "No Federal Action" is taken; to define the problems, needs, and opportunities as discerned from the concerns expressed; and finally to identify the planning constraints and objectives apropos to this study.

NATIONAL OBJECTIVES

The ultimate objective of all water and land resource planning and development is the promotion of the quality of life. This is accomplished by reflecting societal preferences. The Congress and the President have defined the national objectives (or goals) which guide water and land resource planning through many and varied laws and related actions. These goals are defined by the Principles and Standards for Planning Water and Related Land Resources (P&S), which were established by the Water Resources Council. P&S reflects national priorities for management of these resources by providing that the NED and EQ goals be enhanced co-equally.

National Economic Development (NED)

In promoting the quality of life, NED is achieved by increasing the value of the Nation's output of goods and services and improving economic efficiency. For this Western Lake Erie Shore Study, the primary tangible economic benefits associated with the NED account are shoreline erosion prevention on publicly-owned lands and inter-dependent recreational development, and flood damage reduction.

Environmental Quality (EQ)

Environmental quality is achieved by the management, conservation, preservation, creation, restoration, or improvement of the quality of certain natural resources and ecological systems.

These NED and EQ goals serve to guide the entire planning process. Therefore, the identification of problems, needs and opportunities, as well as the formulation of plans and the evaluation of their impacts must be accomplished with full recognition of the ultimate goals or attaining NED and EQ.

PREVIOUS STUDIES, AUTHORIZED AND CONSTRUCTED PROJECTS

Numerous studies have been performed along the Western Shore of Lake Erie by the Corps of Engineers and other Federal and non-Federal agencies. In some instances, water resource projects have been authorized and constructed as a result of these studies. The studies have been reviewed with the view of identifying the types and location of the water-related problems and needs in the study area bounded on the west by the Michigan-Ohio line and on the east by Marblehead, Ohio (see Figure A1 of Section A). A synopsis of the pertinent constructed projects, authorized but unconstructed projects, and previous studies follows.

Constructed Water Resources Projects

The location of completed water resources projects in the study area are shown on Figure B1, following. These projects are:

1. Operation Foresight Temporary Flood Protection Projects - As a result of forecasted high water levels on all of the Great Lakes (except Lake Superior) in 1972, temporary flood control works were constructed in 59 communities on the lakes in 1973 and 1974. The Operation Foresight projects in the study area are:

a. Point Place, Toledo, Ohio - This temporary project consists of earth and stone armored dikes, sand-filled cribs, and rock-filled cribs with appurtenant structures. Total cost of construction was $1.6 million. Photographs B-1 and B-2 show typical construction.

b. Reno Beach - Howard Farms, Ohio - Temporary project consists of constructing 46,000 feet of stone and earth dikes around the periphery of the area at a cost of about $3.6 million. Photographs B-3 and B-4 show typical construction.

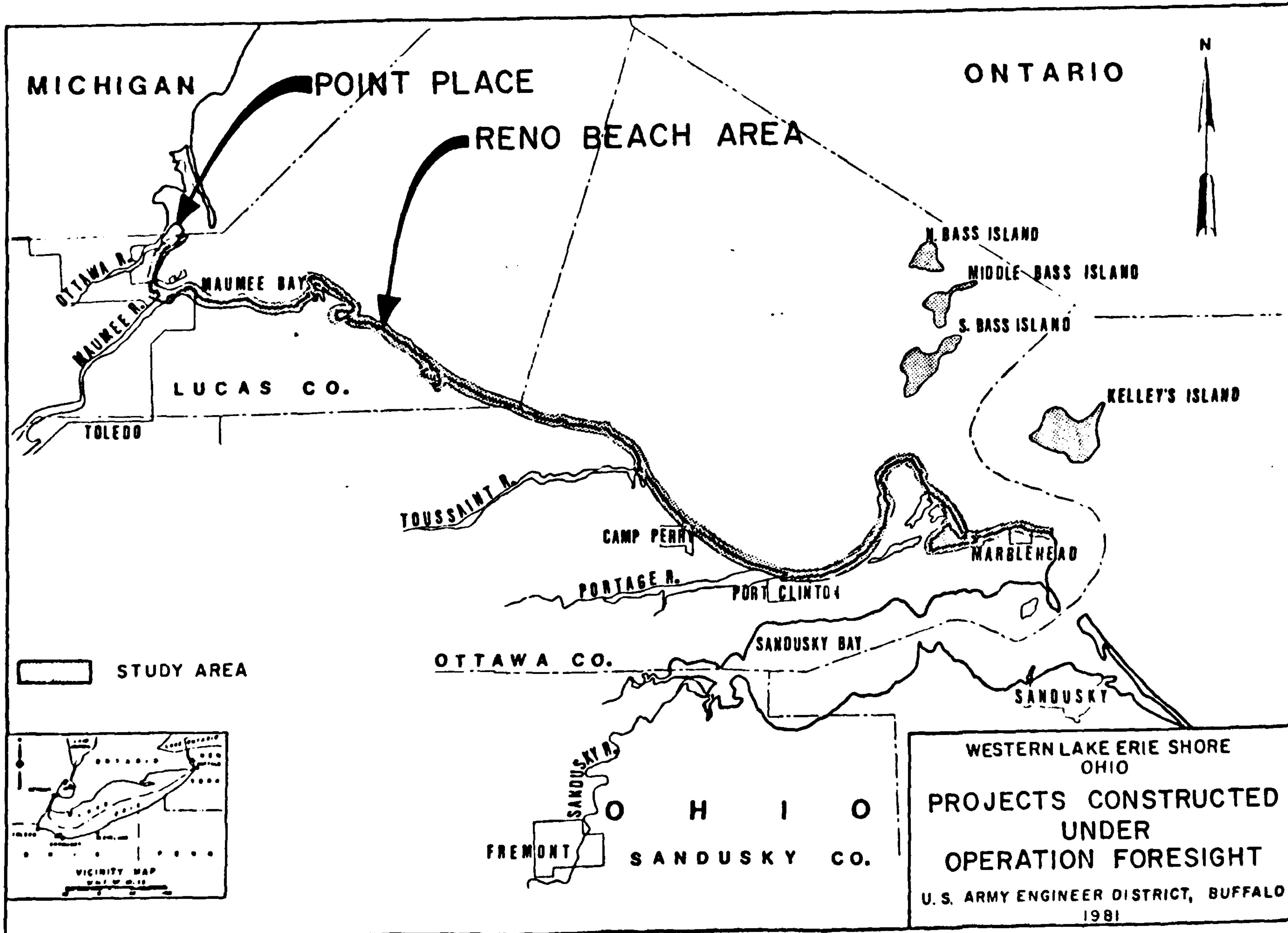

MICHIGAN
POINT PLACE
RENO BEACH AREA
ONTARIO
N
N. BASS ISLAND
MIDDLE BASS ISLAND
S. BASS ISLAND
KELLEY'S ISLAND
OTTAWA R.
MAUMEE BAY
MAUMEE R.
LUCAS CO.
TOLEDO
TOUSSAINT R.
CAMP PERRY
PORTAGE R.
PORT CLINTON
MARBLEHEAD
SANDUSKY BAY
OTTAWA CO.
SANDUSKY
STUDY AREA
SANDUSKY R.
OHIO
FREMONT
SANDUSKY CO.
VICINITY MAP
WESTERN LAKE ERIE SHORE
OHIO
PROJECTS CONSTRUCTED
UNDER
OPERATION FORESIGHT
U.S. ARMY ENGINEER DISTRICT, BUFFALO
1981

FIGURE B1

PHOTO B-1
POINT PLACE
OCT. 78

PHOTO B-2
POINT PLACE
OCT. 78

PHOTO B-3
RENO BEACH
OCT. 78

PHOTO B-4
RENO BEACH
OCT. 78

2. Toledo Harbor - Commercial harbor improvements began in 1866 and have continued to the present. The project consists of about 25 miles of channel deepening at a total Federal cost of $17.2 million. About $17.1 million has been spent on maintaining authorized channel depths. Average annual water-borne traffic through Toledo Harbor has averaged about 24 million tons in recent years.

3. Section 14 - Emergency Bank Protection at Oregon Pumping Station, Ohio. - This project, completed in 1978, consists of constructing a clay and stone dike to protect the City's water pumping station as shown in Photograph B5.

4. Cedar Point, Ohio, Wildlife Refuge - The U.S. Fish and Wildlife Service rehabilitated 5 miles of lakefront dike in 1967-68 to maintain an existing wetland in the Refuge. In 1976-77, broken dikes were repaired and the project was completed at a Federal cost of $1.5 million.

5. Lacarne-Camp Perry, Ottawa County, Ohio Local Flood Protection Project - This flood control and beach erosion project comprises 3,250 feet of levee along Lake Erie and 3,650 feet of tieback dike. It was completed in 1954 by Detroit District at a Federal cost of $150,000.

6. Darby and Ottawa Divisions, Ottawa National Wildlife Refuges - In 1975-76, more than 1.5 miles of lakefront dike in the Darby Division were rehabilitated by the USF&WLS at a Federal cost of $1 million. In addition, a 3/4-mile lakefront dike was recently constructed in the Ottawa Division at a cost of $0.5 million.

7. Port Clinton, Ohio, Small-Boat Harbor - Federal improvements consisting of jetty protection at the entrance and harbor deepening were completed in 1893 at a Federal cost of $72,000.

8. Catawba Island, Ohio, Section 14 Emergency Shore Protection Project - Construction consisted of limestone-and-clay fill and stone were placed to protect Sand Road. The work was completed in 1978 under a $197,000 contract.

9. Put-in Bay-Harbor, South Bass Island, Ohio - The harbor front area was dredged by the Corps in 1939 at a Federal cost of about $52,000.

10. Kelley's Island Section 14 Emergency Protection Project - Shore protection of a highway consisting of a total of 1,500 feet of stone revetment at four separate locations was completed in 1978.

Authorized Corps Projects Not Constructed

Following is a brief description and status of the four water resources projects within the study area that have been authorized but, as of March 1981, not yet constructed. The locations of these sites are shown on Figure B2.

1. Point Place Local Flood Protection Project - Authorized in October 1972 under Section 201 of the 1965 FCA, this project would protect 210 acres of residential property from Lake Erie flooding. Preconstruction planning

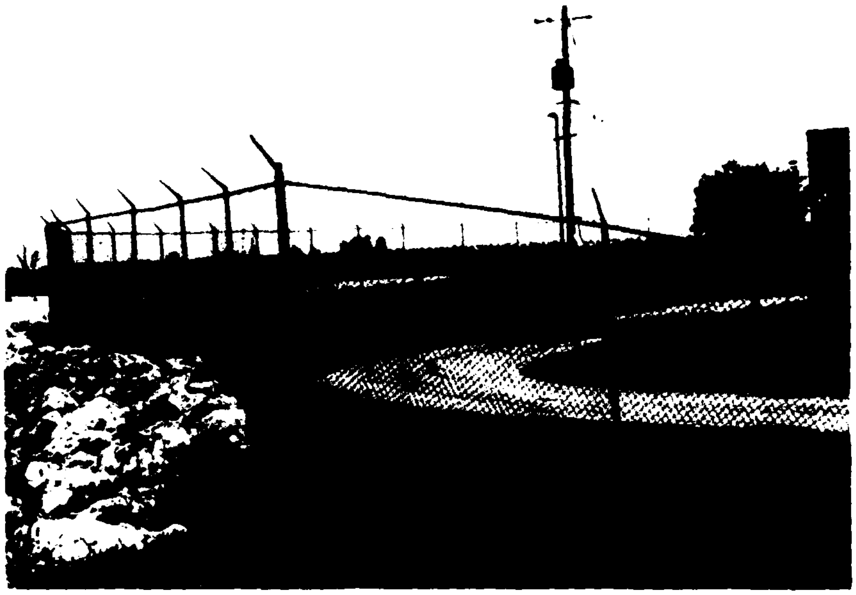


PHOTO B-5
OREGON PUMPING
STATION
OCT. 78

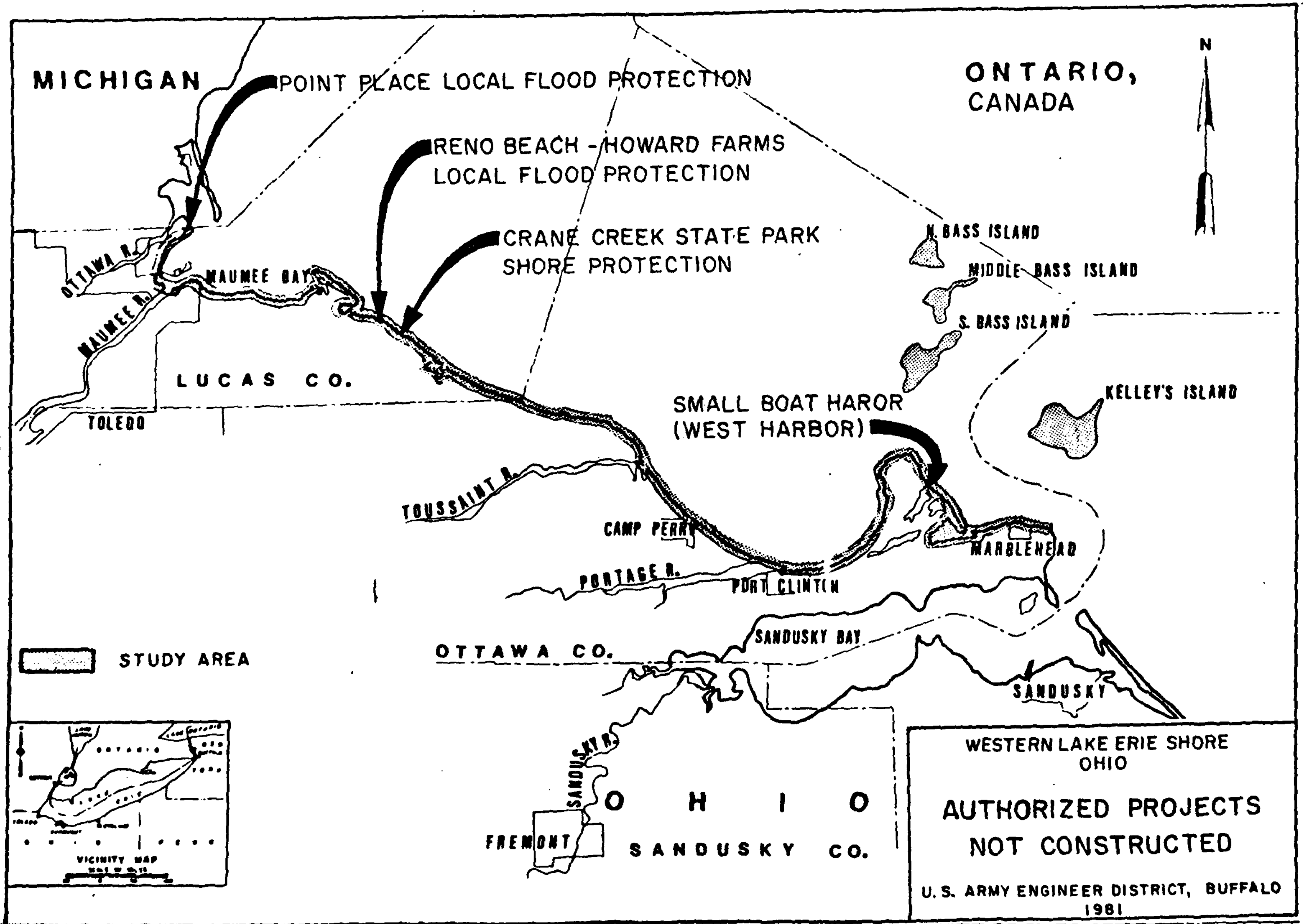

MICHIGAN
POINT PLACE LOCAL FLOOD PROTECTION
RENO BEACH - HOWARD FARMS LOCAL FLOOD PROTECTION
CRANE CREEK STATE PARK SHORE PROTECTION
ONTARIO, CANADA
N
N. BASS ISLAND
MIDDLE BASS ISLAND
S. BASS ISLAND
KELLEY'S ISLAND
SMALL BOAT HAROR (WEST HARBOR)
OTTAWA R.
MAUMEE BAY
MAUMEE R.
LUCAS CO.
TOLEDO
TOUSSAINT R.
CAMP PERRY
PORTAGE R.
PORT CLINTON
MARBLEHEAD
SANDUSKY BAY
OTTAWA CO.
SANDUSKY
STUDY AREA
SANDUSKY R.
OHIO
FREMONT
SANDUSKY CO.
VICINITY MAP
WESTERN LAKE ERIE SHORE OHIO
AUTHORIZED PROJECTS NOT CONSTRUCTED
U. S. ARMY ENGINEER DISTRICT, BUFFALO 1981

FIGURE B2

was initiated in 1972 and is presently (March 1981) in the final design stage. Major construction for this $10 million project, shown on Figure B3, is scheduled to start late in Fiscal Year 1981.

2. Reno Beach - Howard Farms Local Flood Protection Project - Figure B4 shows the project authorized under Section 203 of the 1948 River and Harbor Act. Preconstruction planning was initiated in Fiscal Year 1980, and Stage 2 of the Reformulation Phase I General Design Memorandum is tentatively scheduled to begin late in Fiscal Year 1981.

3. Crane Creek State Park Shore Protection Project - This project, shown on Figure B5, was authorized by the 1962 Flood Control Act. It would include restoration and protection of the park shoreline by construction of a sand barrier beach along 17,800 feet of shore at a total first cost of about $7.8 million. Because of lack of support by local interests, the Crane Creek State Park project was deauthorized on 2 November 1979 under the authority of Section 12 of Public Law 93-251.

4. West Harbor Small-Boat Harbor - This small-boat harbor, shown on Figure B6, was authorized by the River and Harbor Act of 1965. The principal feature of the authorized Federal improvements consist of constructing a breakwater-protected entrance from Lake Erie into the natural outlet of West Harbor, with access channels leading to the existing berthing areas. Preconstruction planning has been completed and construction of this $7.9 million project is scheduled to begin in spring 1981.

Other Studies

In addition to the studies that resulted in the authorized and constructed water resources projects discussed above, several other pertinent studies have been conducted within the study area.

1. Beach Erosion Study, Ohio Shoreline of Lake Erie from Ohio-Michigan State Line to Marblehead, Ohio - This study, conducted by the Beach Erosion Board in 1944 and published in House Document No. 177, 79th Congress, 1st Session, addressed the erosion problem along the same reach of Lake Erie shoreline covered by the Western Lake Erie Shore study and is the basis for this review of reports. The Board concluded that, with the exception of further study for flood control improvements at Reno Beach, it was not advisable for the United States to adopt a project in the study area at that time. It did identify sites at Cooley Creek, Ward Canal, Turtle Creek, and Lacarpe Creek as suitable areas for potential recreational facilities.

2. Lake Erie Shore/Line from the Michigan-Ohio State Line to Marblehead, Ohio, Beach Erosion Control Study - This restudy of the 1945 Beach Erosion Study was completed in 1960 by the Detroit District and published in House Document No. 63, 87th Congress, 1st Session on 23 January 1961. The primary purpose of this restudy of the 60-mile reach of Lake Erie Shoreline was to develop plans and estimates of cost for restoration and protection of public-owned shares at Metzger Marsh, Crane Creek State Park, East Harbor State Park, and State Highway 2 at Port Clinton. This study led to the authorization of the Crane Creek State Park project, which - as discussed in the

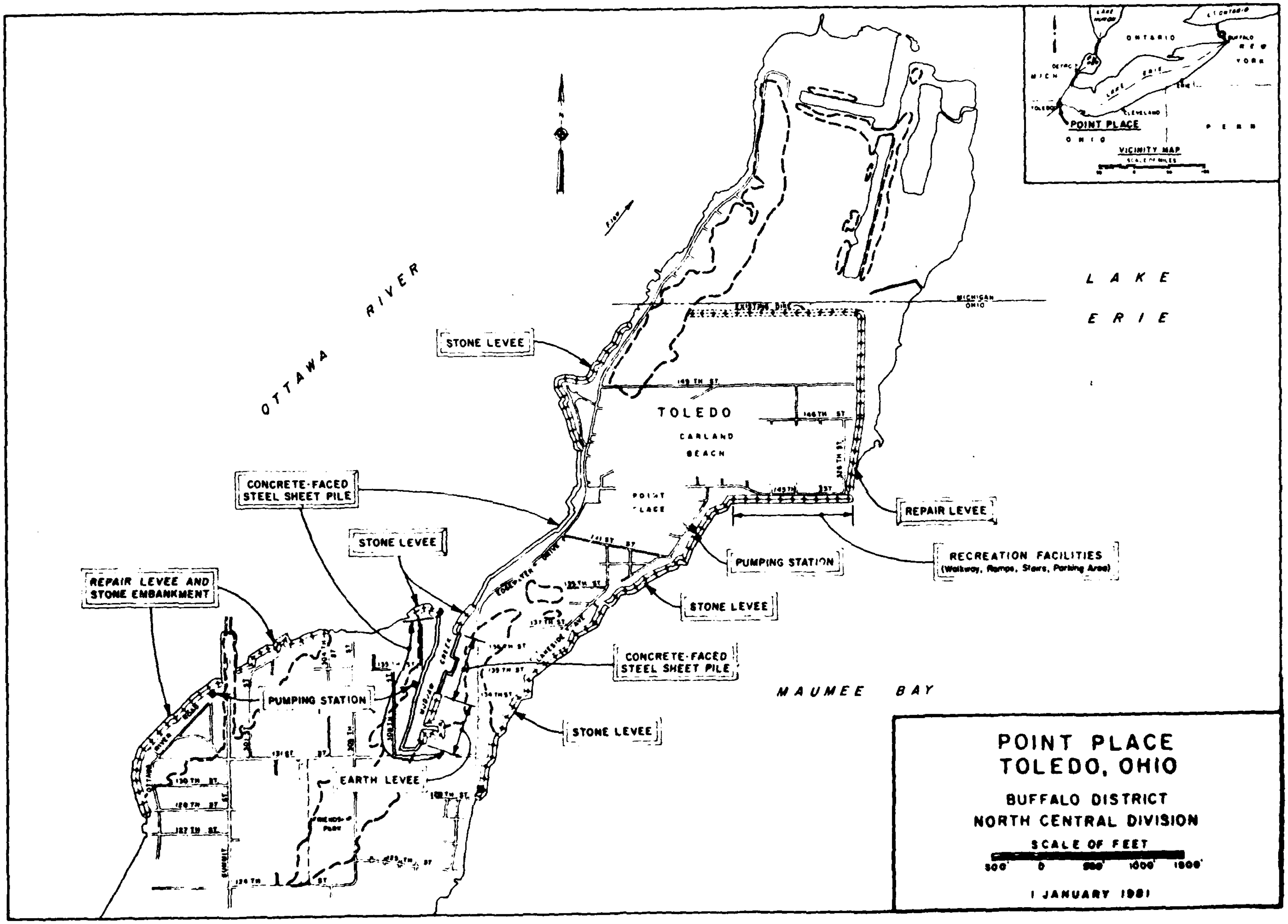

LAKE ERIE
MAUMEE BAY
OTTAWA RIVER
TOLEDO
CARLAND BEACH
POINT PLACE
STONE LEVEE
CONCRETE-FACED STEEL SHEET PILE
STONE LEVEE
REPAIR LEVEE AND STONE EMBANKMENT
PUMPING STATION
EARTH LEVEE
REPAIR LEVEE
RECREATION FACILITIES (Walkway, Ramps, Stairs, Parking Area)
PUMPING STATION
STONE LEVEE
CONCRETE-FACED STEEL SHEET PILE
STONE LEVEE
MICHIGAN
OHIO
POINT PLACE
TOLEDO, OHIO
BUFFALO DISTRICT
NORTH CENTRAL DIVISION
SCALE OF FEET
500 0 500 1000 1500
1 JANUARY 1981
ONTARIO
NEW YORK
PENN
OHIO
MICH
POINT PLACE
VICINITY MAP

FIGURE B3

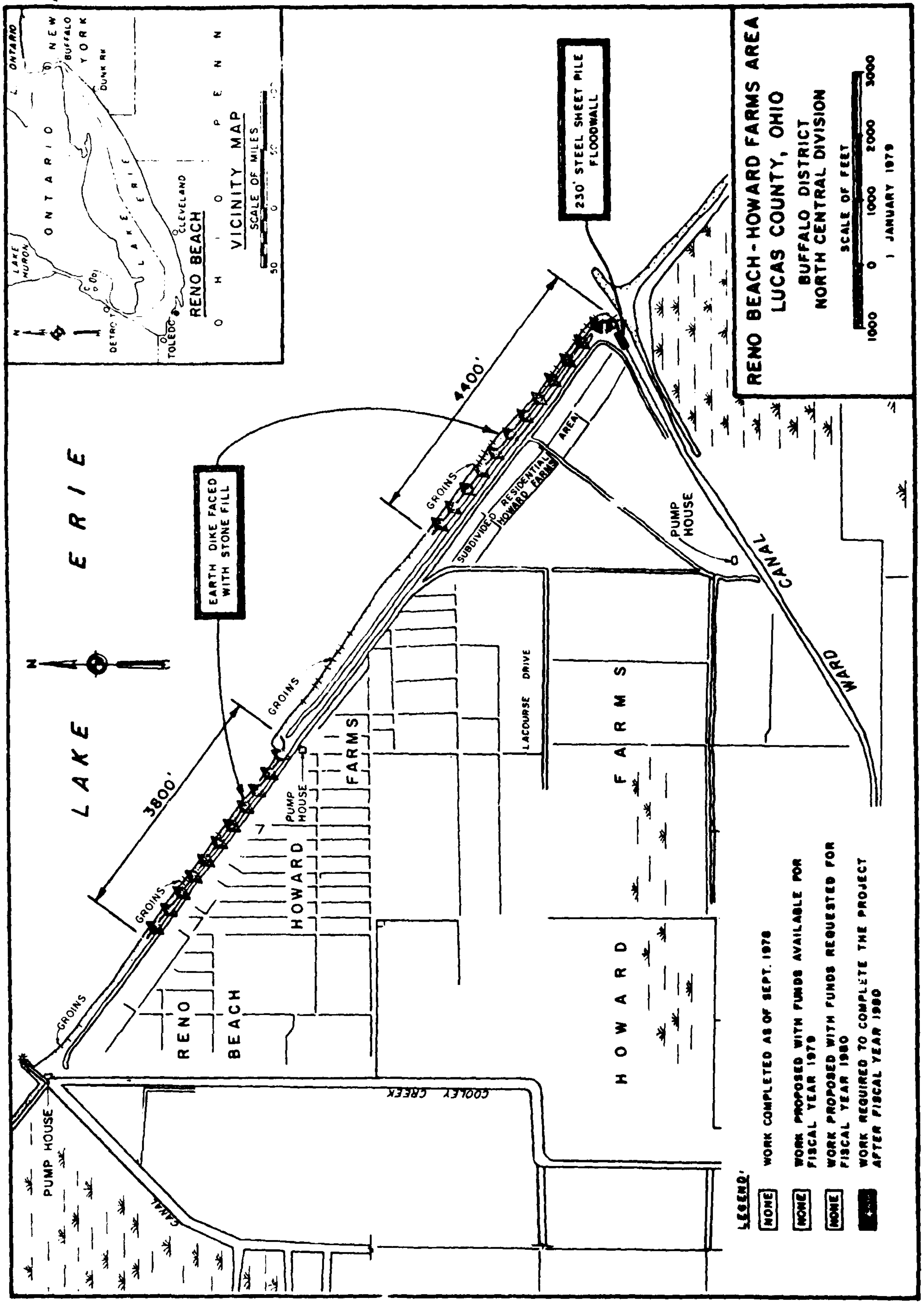

RENO BEACH-HOWARD FARMS AREA
LUCAS COUNTY, OHIO
BUFFALO DISTRICT
NORTH CENTRAL DIVISION
SCALE OF FEET
1000 0 1000 2000 3000
1 JANUARY 1979
VICINITY MAP
SCALE OF MILES
RENO BEACH
ONTARIO
LAKE ERIE
OHIO
PENN
NEW YORK
TOLEDO
DETROIT
CLEVELAND
BUFFALO
LAKE HURON
LAKE ERIE
230' STEEL SHEET PILE FLOODWALL
EARTH DIKE FACED WITH STONE FILL
4400'
3800'
GROINS
SUBDIVIDED RESIDENTIAL HOWARD FARMS AREA
PUMP HOUSE
CANAL
WARD CANAL
LACOURSE DRIVE
HOWARD FARMS
RENO BEACH
COOLEY CREEK
LEGEND:
NONE WORK COMPLETED AS OF SEPT. 1978
NONE WORK PROPOSED WITH FUNDS AVAILABLE FOR FISCAL YEAR 1979
NONE WORK PROPOSED WITH FUNDS REQUESTED FOR FISCAL YEAR 1980
WORK REQUIRED TO COMPLETE THE PROJECT AFTER FISCAL YEAR 1980

FIGURE B4

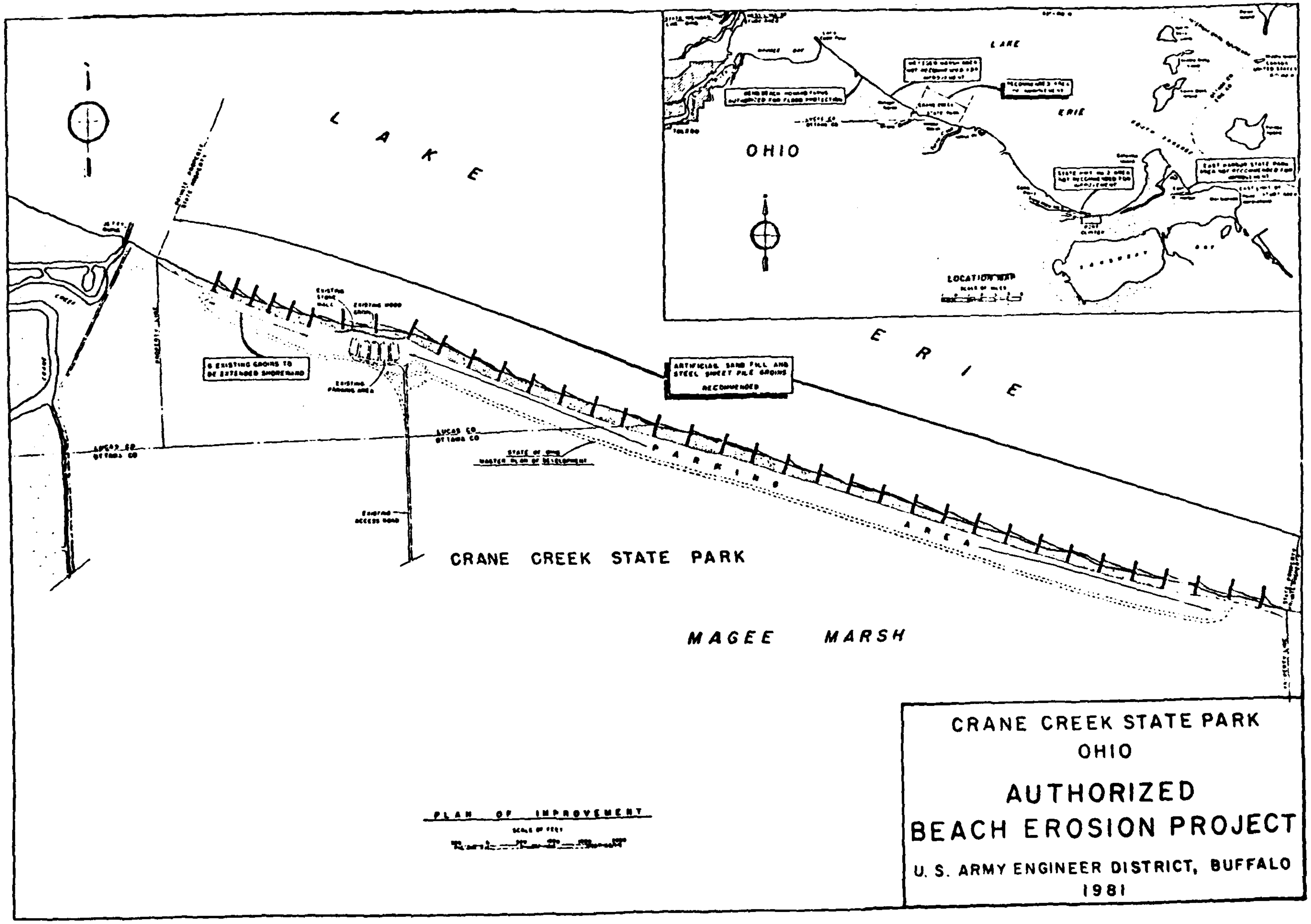

LAKE
ERIE
OHIO
CRANE CREEK STATE PARK
MAGEE MARSH
PARKING AREA
ARTIFICIAL SAND FILL AND STEEL SHEET PILE GROINS RECOMMENDED
6 EXISTING GROINS TO BE EXTENDED SHOREWARD
EXISTING PARKING AREA
EXISTING ACCESS ROAD
LUCAS CO
OTTAWA CO
STATE OF OHIO MASTER PLAN OF DEVELOPMENT
LOCATION MAP
PLAN OF IMPROVEMENT
CRANE CREEK STATE PARK
OHIO
AUTHORIZED
BEACH EROSION PROJECT
U. S. ARMY ENGINEER DISTRICT, BUFFALO
1981

FIGURE B5

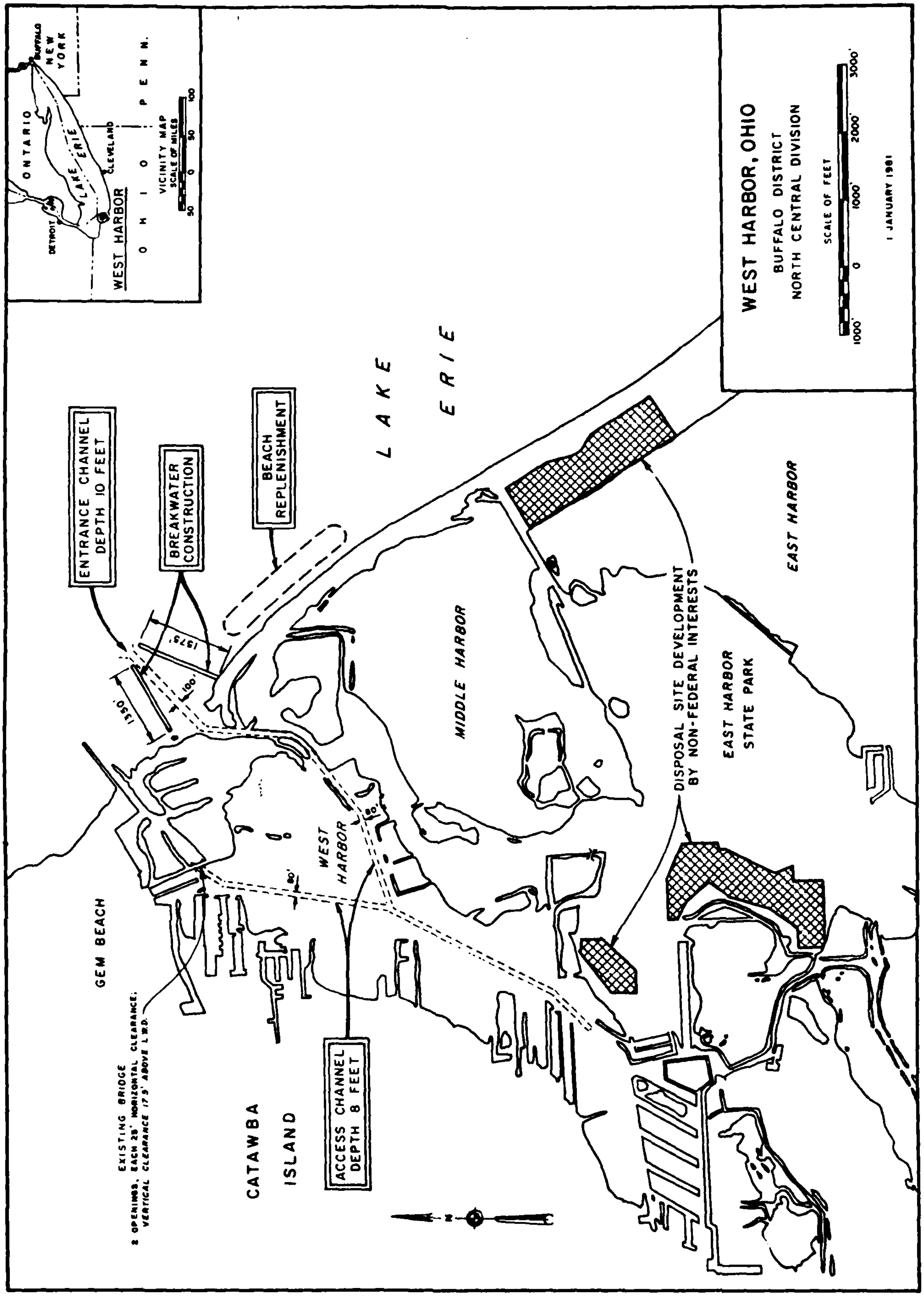

WEST HARBOR, OHIO
BUFFALO DISTRICT
NORTH CENTRAL DIVISION
SCALE OF FEET
1000' 0 1000' 2000' 3000'
1 JANUARY 1981
WEST HARBOR
ONTARIO
LAKE ERIE
DETROIT
CLEVELAND
BUFFALO
NEW YORK
O H I O
P E N N.
VICINITY MAP
SCALE OF MILES
50 0 50 100
L A K E
E R I E
ENTRANCE CHANNEL
DEPTH 10 FEET
BREAKWATER
CONSTRUCTION
BEACH
REPLENISHMENT
1575'
1350'
100'
MIDDLE HARBOR
DISPOSAL SITE DEVELOPMENT
BY NON-FEDERAL INTERESTS
EAST HARBOR
EAST HARBOR
STATE PARK
WEST
HARBOR
80'
80'
GEM BEACH
EXISTING BRIDGE
2 OPENINGS, EACH 25' HORIZONTAL CLEARANCE;
VERTICAL CLEARANCE 17.5' ABOVE L.W.D.
CATAWBA
ISLAND
ACCESS CHANNEL
DEPTH 8 FEET
N

FIGURE B6

preceding subsection - has since been deauthorized. No other projects were recommended for authorization at that time.

3. Lake Erie Water Level Study - The International Lake Erie Regulation Study Board was established in May 1977 by the International Joint Commission (IJC) to make a detailed study of the possibilities for limited regulation of Lake Erie with the objective of lowering high-water levels to reduce shoreline erosion and flooding. The preliminary findings, released in August 1980 and included as Exhibit G9 of Appendix G, show that the alternatives considered would produce negative benefits (losses) in all cases. The Board's final report is presently being prepared for submittal to the IJC.

4. Preliminary Examination of Shores of Lake Erie for Harbors and Harbors-of-Refuge for Light-Draft Vessels - Preliminary studies of recreational navigation needs along Lake Erie were prepared in 1946 by Buffalo and Detroit Districts for their respective reaches of Lake Erie shoreline. As a result of this study, the Chief of Engineers authorized further study and preparation of Survey Reports for 35 specific locations in Michigan, Ohio, Pennysylvania, and New York. The aforementioned project at West Harbor was authorized as a result of this study authority. The following locations for small-boat harbors were identified for further study within the reach of Lake Erie encompassed by the Western Lake Erie Shore study and are shown on Figure B7, following:

Cooley Creek, Ohio
Turtle Creek, Ohio
Port Clinton, Ohio
West Harbor, Ohio
East Harbor, Ohio
Put-in-Bay, Ohio
Kelley's Island, Ohio

A "Resurvey" of the 1946 Preliminary Examination Report was initiated in 1979 at the request of Ohio Department of Natural Resources. The objective of this Resurvey is to identify, and recommend for further study, possible harbors and harbors-of-refuge along the Lake Erie shoreline for recreational craft based on present boating needs. The Resurvey has been suspended pending additional funding to complete the Resurvey.

5. National Shoreline Study, Great Lakes Region Inventory Report - The report, dated August 1971 and published as House Document No. 93-121, 93rd Congress, 1st Session, was prepared by the North Central Division of the Corps of Engineers. The purpose of this appraisal investigation was to define the magnitude of the shore erosion problems on the Great Lakes.

PUBLIC CONCERNS

In January 1979, the Buffalo District conducted two Orientation Workshops in the study area. The primary purpose of these workshops was to identify issues, concerns, and problems relative to the water and related land resources within the 60-mile reach of Lake Erie covered by this study.

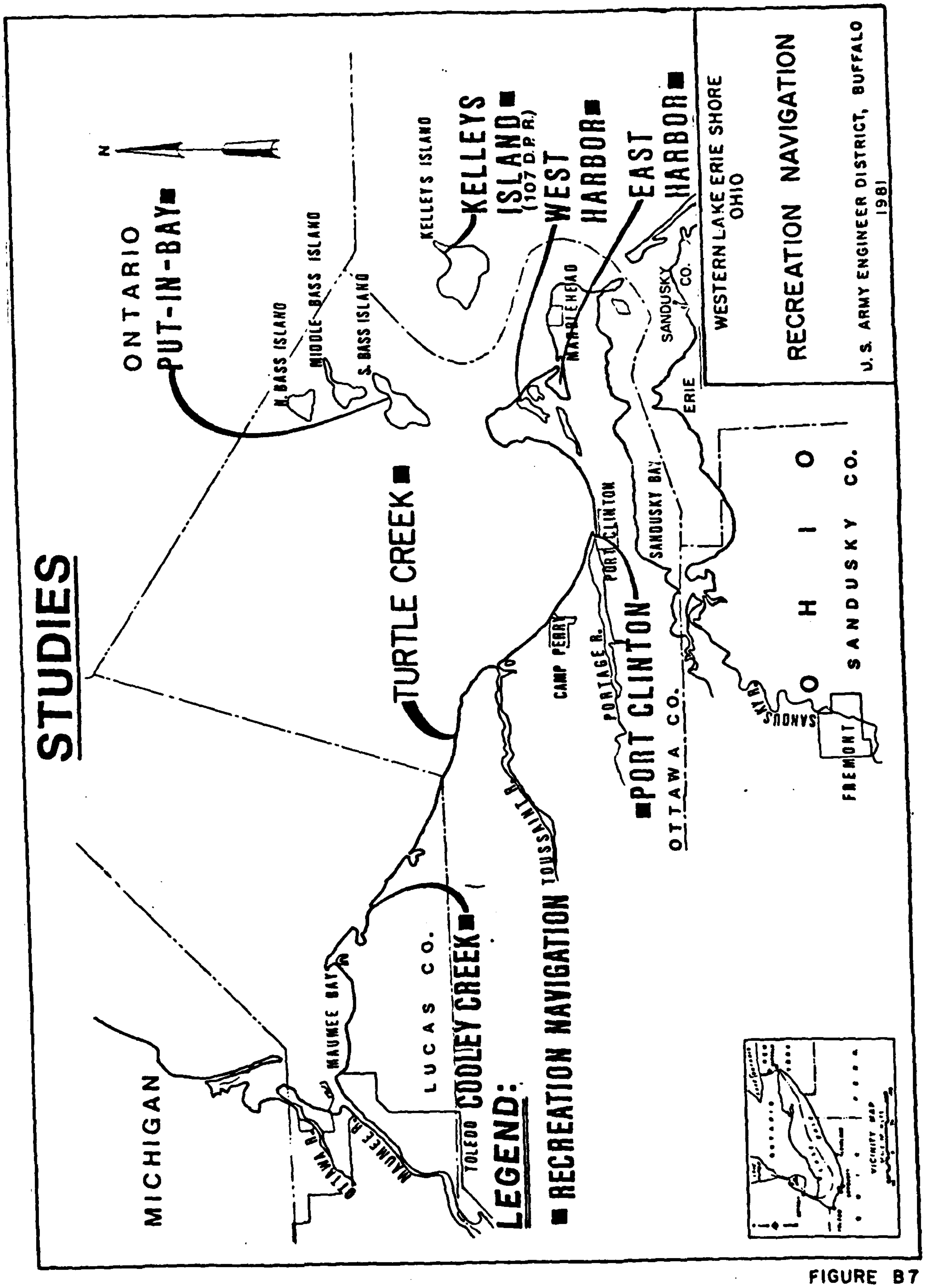

STUDIES
MICHIGAN
ONTARIO
PUT-IN-BAY
N
N. BASS ISLAND
MIDDLE BASS ISLAND
S. BASS ISLAND
KELLEYS ISLAND
KELLEYS
ISLAND
(107 D.P.R.)
WEST
HARBOR
EAST
HARBOR
MARBLEHEAD
TURTLE CREEK
OTTAWA R.
MAUMEE BAY
MAUMEE R.
LUCAS CO.
TOLEDO
COOLEY CREEK
LEGEND:
RECREATION NAVIGATION
TOUSSAINT R.
CAMP PERRY
PORTAGE R.
PORT CLINTON
PORT CLINTON
SANDUSKY BAY
OTTAWA CO.
ERIE
SANDUSKY
CO.
SANDUSKY R.
OHIO
FREMONT
SANDUSKY CO.
VICINITY MAP
WESTERN LAKE ERIE SHORE
OHIO
RECREATION NAVIGATION
U.S. ARMY ENGINEER DISTRICT, BUFFALO
1981

FIGURE B7

Participants at the workshops identified issues, concerns, and site-specific water resource problems and needs they felt should be addressed in the study. This initial contact and discussion with local interests provided the impetus for further discussions and site visitations by District staff to obtain additional information and evaluate the applicability of further study of the problems and needs under this study authority. Information on the workshops and subsequent field visitations is included as Exhibits G2 through G8 of Appendix G.

A total of about 20 problem areas were identified as a result of this public involvement program. The general locations of these problem areas - some specific and some encompassing a general reach of shoreline - are depicted on Figure B8. From Figure B8, it is seen that the perceived problems and needs include beach and shoreline erosion, flooding, water quality, and recreational navigation. These problem areas, and the Districts' evaluation regarding further consideration under the Western Lake Erie Shore study, are discussed in subsequent sections of this reconnaissance report.

EXISTING CONDITIONS

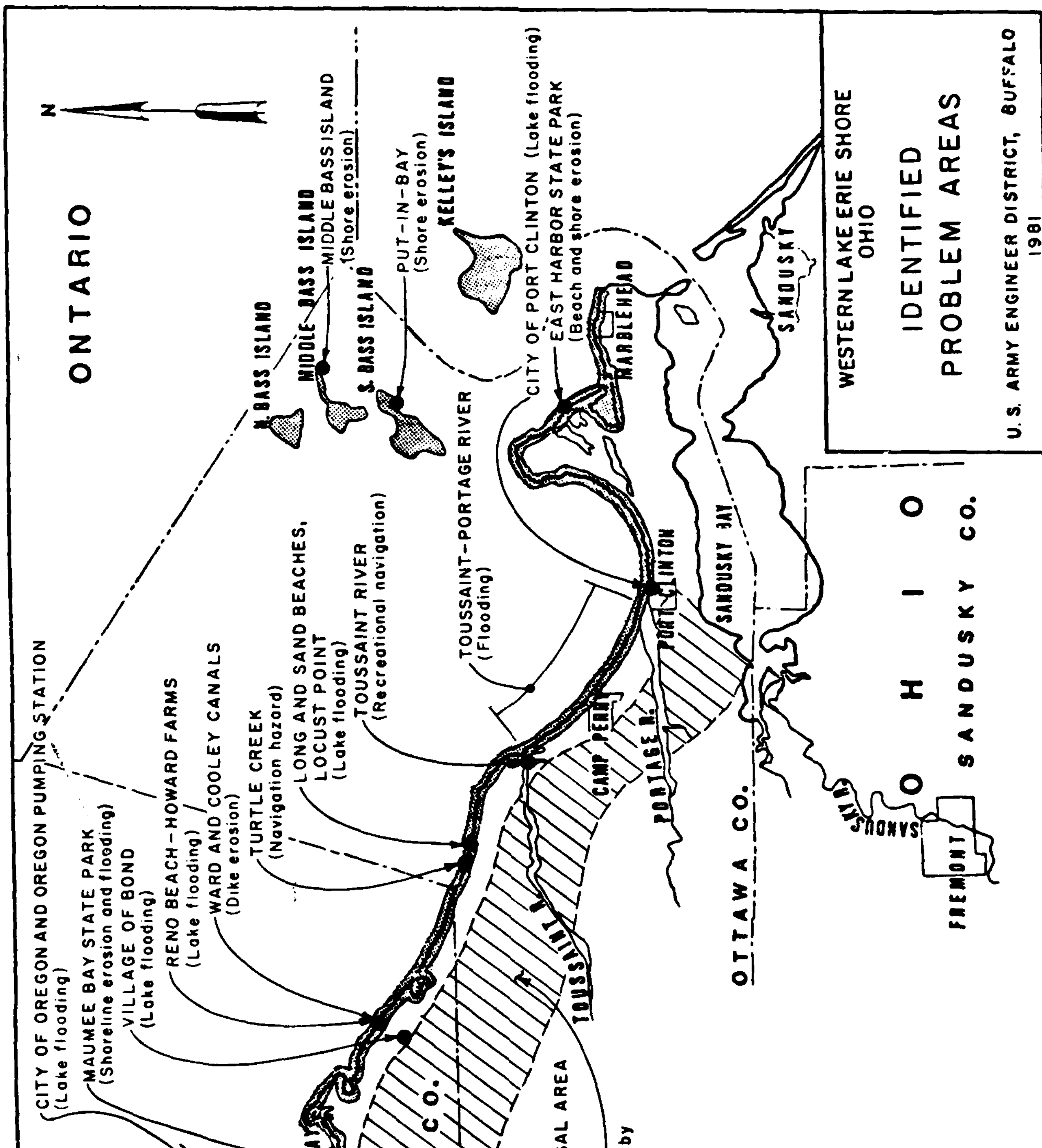
An accurate and comprehensive environmental, social, and economic resource data base is essential to effective planning for development of water resources. In developing this base, early identification of existing conditions is essential. This data base is then refined throughout the study, thus providing a rational basis for assessment and evaluation of probable outcomes of alternative plans, and ultimately for selecting a plan of action for recommendation.

To assist in defining this resource base, a Preliminary Fish and Wildlife Coordination Act Report - including a literature search - was prepared by the U. S. Fish and Wildlife Service. A copy of this report, dated November 1979, is included in Appendix E. In addition, an extensive review of pertinent available literature and reports was performed by Buffalo District to establish the available data base for the study area. A relatively detailed flood damage survey was also performed by Buffalo District for the Port Clinton area and the city of Oregon during Stage 1 to establish current stage-damage relationships to be used in determining Federal interest in flood protection projects within the study area.

The following is a brief description, or profile, of existing conditions along the 60-mile reach of Lake Erie shoreline in the study area. This profile consists of: (1) the natural environment, characterized by the physical, geological, atmospheric and biological features; and (2) the human environment, characterized by the demographic, social, culteral and economic features in the study, and contiguous areas.

Natural Environment

1. Physiography - The five Great Lakes . . . Superior, Michigan, Huron, Erie, and Ontario . . . have a total surface area of about 95,000 square miles, and collectively with their connecting channels and Lake St. Claire comprise the largest body of fresh water in the world. Extending from the



WESTERN LAKE ERIE SHORE
OHIO
IDENTIFIED
PROBLEM AREAS
U.S. ARMY ENGINEER DISTRICT, BUFFALO
1981
ONTARIO
MICHIGAN
OHIO
N
HARBOR VIEW-BAY SHORE
(Lake flooding)
WASHINGTON
TOWNSHIP
(Flooding)
CITY OF OREGON AND OREGON PUMPING STATION
(Lake flooding)
MAUMEE BAY STATE PARK
(Shoreline erosion and flooding)
VILLAGE OF BOND
(Lake flooding)
RENO BEACH-HOWARD FARMS
(Lake flooding)
WARD AND COOLEY CANALS
(Dike erosion)
TURTLE CREEK
(Navigation hazard)
LONG AND SAND BEACHES,
LOCUST POINT
(Lake flooding)
TOUSSAINT RIVER
(Recreational navigation)
TOUSSAINT-PORTAGE RIVER
(Flooding)
CITY OF PORT CLINTON (Lake flooding)
EAST HARBOR STATE PARK
(Beach and shore erosion)
PUT-IN-BAY
(Shore erosion)
MIDDLE BASS ISLAND
(Shore erosion)
N. BASS ISLAND
MIDDLE BASS ISLAND
S. BASS ISLAND
KELLEY'S ISLAND
MARBLEHEAD
SANDUSKY
SANDUSKY BAY
PORT CLINTON
CAMP PERRY
PORTAGE R.
TOUSSAINT R.
SANDUSKY R.
FREMONT
OTTAWA CO.
SANDUSKY CO.
LUCAS CO.
MAUMEE BAY
MAUMEE R.
OTTAWA R.
TOLEDO
TOLEDO HARBOR DIKED DISPOSAL AREA
(Possible water quality)
AGRICULTURAL LANDS
(Localized flooding aggravated by
high lake levels)
STUDY AREA
VICINITY MAP

FIGURE B8

western end of Lake Superior to the Atlantic Ocean at the Gulf of St. Lawrence, they provide a navigable water route of more than 2,000 miles. Being a chain-of-lakes, the Great Lakes act as a series of large reservoirs, connected by channels and rivers whereby each lake outflows to the next downstream lake.

Lake Erie, the second smallest of the Great Lakes Chain, has a surface area of about 9,940 square miles, a length of about 241 miles, and a maximum width of 57 miles (see Figure B9). The long axis is oriented in a general southwest-northeast direction along the path of the prevailing southwest winds on the lake. It is the shallowest of the Great Lakes with a maximum recorded depth of 210 feet and an average depth of about 60 feet. The lake body itself is divided into three subbasins: the flat shallow Western Basin with a surface area of 1,200 square miles and a mean depth of about 24 feet; the flat but deeper Central Basin with a surface area of about 6,300 square miles and a mean depth of about 60 feet; and the Eastern Basin with a surface area of about 2,440 square miles and mean depth of 80 feet. The shoreline area covered by this study is located in the shallow Western Basin.

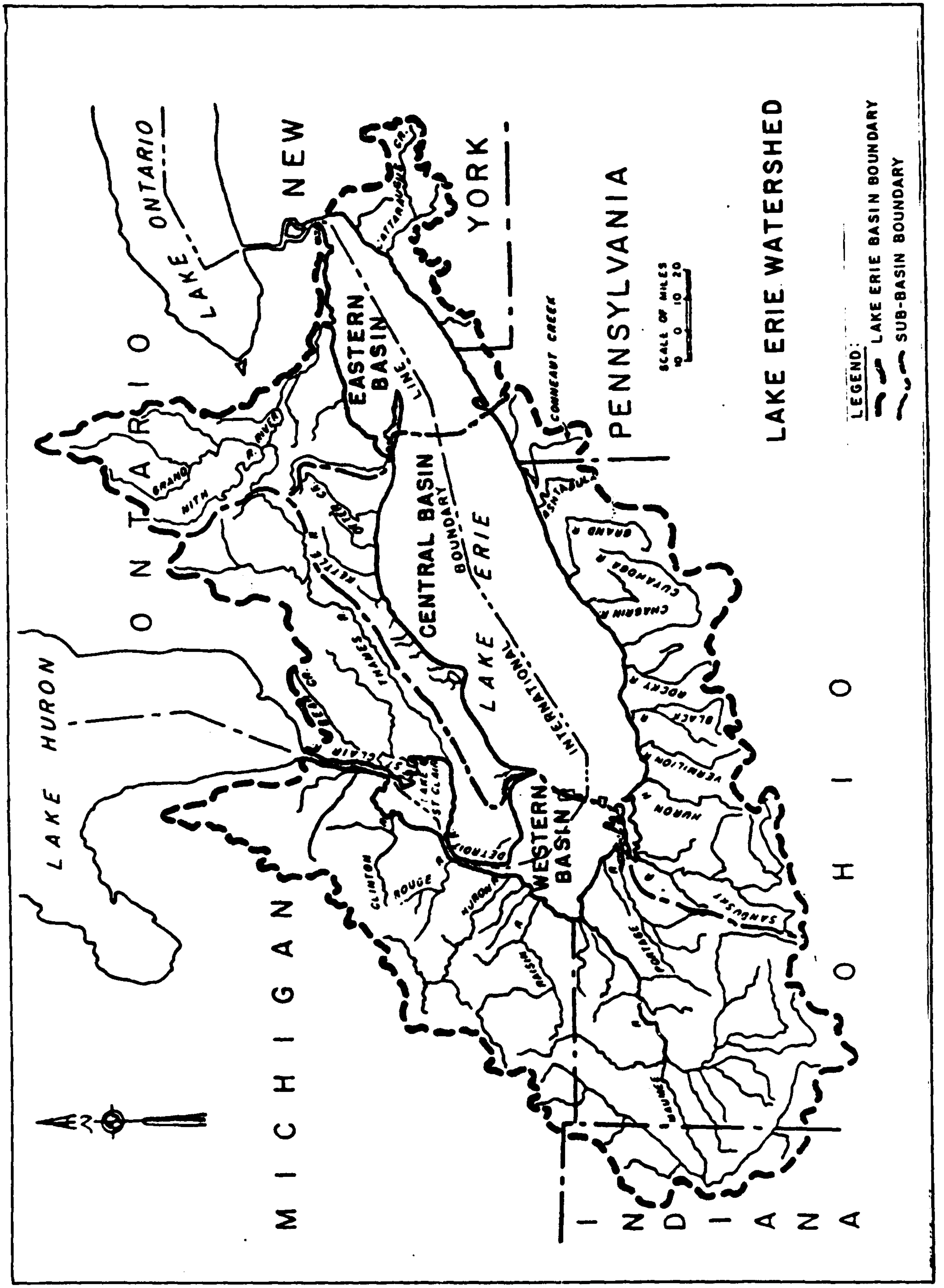
The Lake Erie local drainage area, including its water surface, is approximately 40,000 square miles. Its tributaries are characteristically sluggish and sinewy and carry high silt loads especially in the western reaches of the basin. The Maumee River, with a drainage area of about 6,600 square miles, is the largest tributary watershed to Lake Erie. The major streams in the study area are the Maumee (6,600 square miles) Portage (581 square miles) and Toussaint (143 square miles) Rivers. The Detroit River provides the inflow to Lake Erie from the upper lakes and averages about 184,000 cubic feet per second. Lake Erie's outlet is the Niagara River, and the average outflow is about 206,000 cubic feet per second.

The study area is a relatively narrow band along the Lake Erie shoreline in Lucas and Ottawa counties, Ohio, as shown on Figure A1 of Section A. It is characterized as an area of low, flat relief generally being less than 5 feet above the level of Lake Erie except in areas where shoreline protection has been constructed. The drainage network within the study area is typically small streams and ditches of very flat gradient.

2. <u>Topography of Study Area</u> - The topography of the study area is a product of the Pleistocene Glaciation. Flat valley floors, kame deposits, and ancient beach ridges are topographic features located in this region These ancient beach ridges resulted from higher than present day lake levels. The highest of these beach ridges is approximately 200 feet above lake level and is 20 miles from shore.

3. <u>Geology of the Area</u> - The surficial geology of the southwestern Lake Erie shoreline is mainly lacustrine deposits. These are composed of silt and clay which range in thickness from 5 to 50 feet. Underlying these lacustrine deposits is mainly glacial till composed of sand, gravel, and clay.

The Lake Erie shoreline bedrock in the area from the Marblehead Peninsula to Toledo is Silurian limestone from the Monroe Formation and Silurian limestone and shale from the Niagara Formation. Pelee Island and Kelley's Island lie



LAKE ERIE WATERSHED
LEGEND:
LAKE ERIE BASIN BOUNDARY
SUB-BASIN BOUNDARY
SCALE OF MILES
10 0 10 20
LAKE HURON
LAKE ONTARIO
LAKE ERIE
LAKE ST. CLAIR
MICHIGAN
ONTARIO
NEW YORK
PENNSYLVANIA
OHIO
INDIANA
WESTERN BASIN
CENTRAL BASIN
EASTERN BASIN
CENTRAL BASIN BOUNDARY
EASTERN BASIN LINE
INTERNATIONAL
GRAND
NITH R.
R. RIVER
CATTARAUGUS CR.
CONNEAUT CREEK
ASHTABULA
GRAND R.
CUYAHOGA R.
CHAGRIN R.
ROCKY R.
BLACK R.
VERMILION R.
HURON R.
SANDUSKY
PORTAGE
MAUMEE
RAISIN
HURON
ROUGE R.
CLINTON
DETROIT
ST. CLAIR
THAMES R.
KETTLE R.

FIGURE B9

in the zone of the Columbus limestone and the Bass Island and Sisters Islands lie in the zone of the Upper Bass Island dolomite.

The central and eastern portions of Lake Erie are located along the strike of a simple structure in which the beds are tilted to the south. The basin of the lake east of Sandusky lies in Devonian limestones. In the narrow eastern basin, where the angle of dip of the rock steepens, the Devonian shales were more easily eroded, thus forming the deepest basin in the lake. Along the southern border of the Erie basin eastward from Cleveland, there is an escarpment composed mainly of Mississipian sandstone and shales rising 200 to 300 feet above the floor of the lake basin.

4. Climate - The climate of the area is typical midcontinental, with moderation by Lake Erie. Because of the moderating effect of Lake Erie, there are only about 15 days per year when the temperature exceeds 90°F and 8 days when it drops below 0°F. The length of the frost-free season adjacent to Lake Erie is from 160 to 179 days. Mean annual precipitation is about 32 inches, distributed uniformly throughout the year. Prevailing winds are from the west-southwest, southwest, and west.

5. Shoreline Conditions - The shoreline of Lake Erie within the study area is about 60 miles in length. Except for the chain of islands at the eastern end of the study reach and in areas where shore protection has been constructed, the shoreline is typically less than 5 feet above the average level of Lake Erie (elevation 570.6 on International Great Lakes Datum of 1955). The shore is about equally divided between low, clay bluffs less than 5 feet in height, barrier beaches which are long, narrow sand ridges separating marsh areas from the open lake, and man-made shore protection works. Other types of shore found in the study area are wetlands and lake plains which are gently sloping land with no discernible abrupt shoreline relief. Photographs B6 through B15 show typical shoreline forms in the study area.

For convenience of description, the study area has been divided into the shoreline subreaches shown on Figure B10. Subreach 1 (SR1), about 3.4 miles of shoreline on the west side of Maumee Bay, is low-lying, primarily privately owned lands except for the city-owned Bay View Park at the mouth of the Maumee River. The area is practically devoid of beaches and the offshore Maumee Bay bottom consists mainly of clay. Various types of shore protective works, including the "Operation Foresight" project at Point Place, have been constructed in this reach.

Subreach 2, on the south and east sides of Maumee Bay, is less developed than SR1, although commercial development associated with Toledo Harbor has taken place near the mouth of the Maumee River and residential development exists eastward to South Shore Park. The shoreline of the remainder of this 8.0-mile subreach is publicly owned lands consisting of Maumee Bay State Park and the Cedar Point Wildlife Refuge. Erosion of the shoreline is critical, approaching 15 to 20 feet per year. Shore protection has been constructed at the Wildlife Refuge and is contemplated for the State Park. Extensive wetlands exist in the partially developed State Park and Wildlife Refuge.

PHOTO B-6
MAUMEE BAY
STATE PARK
OCT. 78

PHOTO B-7
MAUMEE BAY
STATE PARK
NILES BEACH AREA
OCT. 78

PHOTO B-8
CEDAR POINT
WILDLIFE REFUGE
OCT. 78

PHOTO B-9
CRANE CREEK
STATE PARK
AERIAL VIEW
OCT. 78

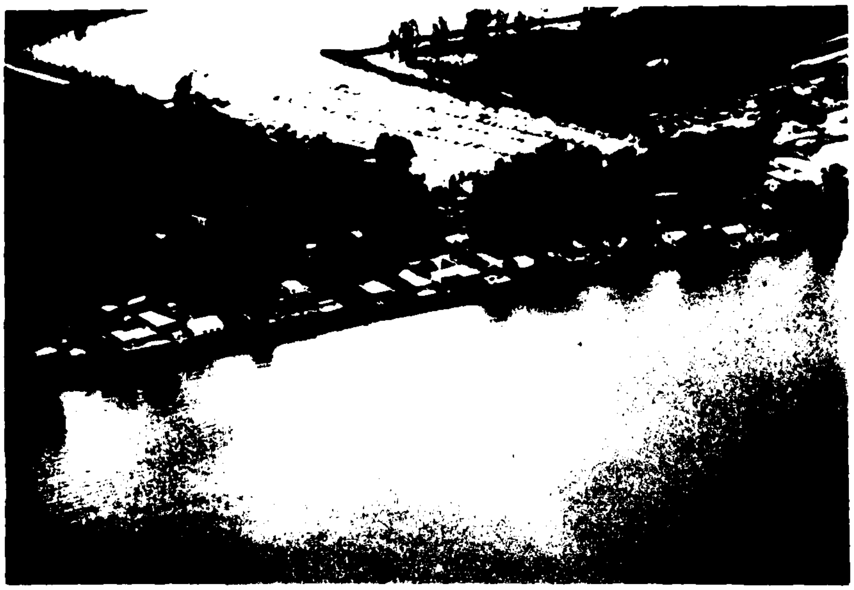


PHOTO B-10
LOCUST POINT
AERIAL VIEW
OCT. 78

PHOTO B-11
SAND BEACH
SOUTHWEST VIEW
OCT. 78

PHOTO B-12
SAND BEACH
SOUTHEAST VIEW WITH
DAVIS BESSE NUCLEAR STATION
IN BACKGROUND
OCT. 78

PHOTO B-13
CAMP PERRY
WESTWARD VIEW
OCT. 78

PHOTO B-14
NORTHERLY TIP OF
CATAWBA ISLAND
OCT. 78

PHOTO B-15
EAST HARBOR STATE PARK
OCT. 78

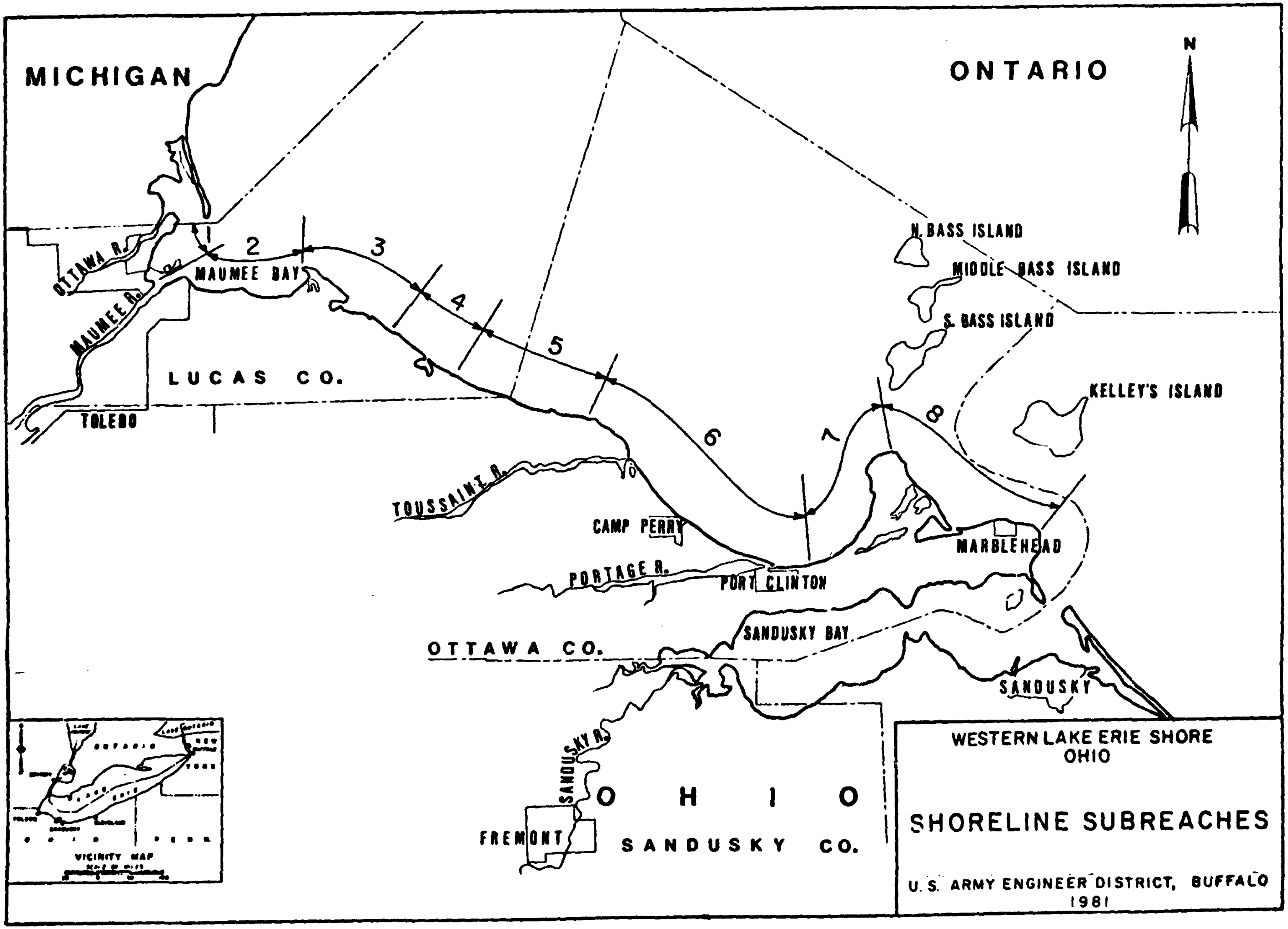

MICHIGAN
ONTARIO
N
N. BASS ISLAND
MIDDLE BASS ISLAND
S. BASS ISLAND
KELLEY'S ISLAND
1
2
3
4
5
6
7
8
OTTAWA R.
MAUMEE R.
MAUMEE BAY
LUCAS CO.
TOLEDO
TOUSSAINT R.
CAMP PERRY
PORTAGE R.
PORT CLINTON
MARBLEHEAD
SANDUSKY BAY
OTTAWA CO.
SANDUSKY
SANDUSKY R.
FREMONT
OHIO
SANDUSKY CO.
VICINITY MAP
WESTERN LAKE ERIE SHORE
OHIO
SHORELINE SUBREACHES
U.S. ARMY ENGINEER DISTRICT, BUFFALO
1981

FIGURE B10

The area has practically no sand beaches except at its easterly limit. Offshore material is clay with a thin overburden of silt.

Subreach 3, which encompasses the remainder of the Cedar Point National Wildlife Refuge, extends a distance of about 4.7 miles from Cedar Point to Cooley Creek. It consists principally of a low barrier beach fronting marsh and swampland. The barrier beach has been breached in several places, and the U. S. Fish and Wildlife Service has constructed protective structures in this undeveloped reach. The offshore lake bottom is primarily clay.

Subreach 4, approximately 3 miles in length, fronts the communities of Reno Beach and Howard Farms. This reclaimed area lies at or near the level of Lake Erie and is protected from flooding by dikes constructed under "Operation Foresight" and private concerns around its entire periphery. Development is concentrated near the shoreline, and the remainder of the protected area is farmland. Preconstruction planning for the Reno Beach - Howard Farms flood protection project was initiated by Buffalo District in Fiscal Year 1979.

Subreach 5, extends eastward from Ward Canal to the mouth of Turtle Creek, a distance of about 6.3 miles. It consists mainly of low, narrow sand beaches fronting on an extensive marshland. This highly productive biological area is primarily publicly owned, and includes the 550 acre State-owned Metzger Marsh at the west end of the reach, and Crane Creek State Park along the remaining 5-1/2 miles of shoreline. Magee Marsh Wildlife area abuts the State Park to the south. This marsh has been developed for fish and game management by the State. The recently deauthorized Crane Creek State Park shore protection project for restoration and protection of the shore using a barrier beach, is in this reach.

Subreach 6, approximately 15 miles in length, extends from Turtle Creek on the west to a point about 2 miles east of the mouth of the Portage River at Port Clinton. Most of the area in this reach is marsh or reclaimed marsh and is used for hunting and trapping. The reclaimed land is concentrated at the shoreline, and is used for residential purposes, farming and garden plots. The communities of Locust Point, Sand Beach, and Long Beach, located a short distance west of the mouth of the Toussaint River are susceptible to flooding from Lake Erie particularly during periods of high lake levels. The Davis Besse nuclear power plant is located a short distance inland from Sand Beach. A Federal shore protection project has been constructed at Camp Perry which is about midway between the mouths of the Toussaint and Portage Rivers. A low sandy shore extends over most of this reach, and miscellaneous types of shore protection structures are found wherever the shoreline has been developed. A thin layer of sand exists in the offshore area.

Subreach 7 extends a distance of about 6 miles in a northeasterly direction to Scott Point at the tip of Catawba Island. This reach of shore is characterized by glacial till and rock bluffs eroded to form pocket bays between projecting rock outcrop headlands. With the exception of Catawba Island State Park, the shore is privately owned and relatively densely developed. Few protective structures exist, and erosion does not appear to be a problem in this reach.

Subreach 8, extending in a southeasterly direction for about 8-1/2 miles from Scott Point to the eastern limit of the study area at Marblehead, varies in characteristic. The shore of the westerly 1.2 miles between Scott Point and Gem Beach is rocky and appears to be stable. In the 3 miles of shoreline from Gem Beach to the eastern end of East Harbor, the shore consists mainly of low sand beaches bordering marsh land. East Harbor State Park is located in this section. The Buffalo District recently completed a Reconnaissance Report on Beach Erosion for East Harbor State Park under Section 103 of the Continuing Authority Program. Because of the high cost of the proposed project, further studies of this problem will be performed under Western Lake Erie Shore study authority as discussed later in this report. The remaining 4-1/2 miles of this reach are privately owned, and the shore consists mainly of rock cliffs with pebble, boulder, and cobble beaches at indentations in the shoreline. This shoreline is relatively stable, although the Buffalo District is presently evaluating the viability of constructing Section 14, Emergency Shoreline Protective Works for three short sections of State Route 163 at Marblehead.

The final reach, Subreach 9, is the offshore islands at the eastern end of the study area. The shores of these islands, South Bass, Middle Bass, North Bass, and Kelley's Island - are chiefly rugged in character with rock bluffs along most of their shorelines. Small sand, cobble, or boulder beaches exist at indentations in the shoreline. The land is primarily devoted to farming, although the summer tourist trade is of economic importance. Because this area is a highly productive fishing area, the State of Ohio is interested in developing a Federal recreational harbor on Kelley's Island to serve the boating need. A Section 14 Emergency Shore Protection Project was constructed at the south end of Kelley's Island in 1978 to protect the threatened South Perimeter Road.

6. Winds - Winds over large, open bodies of water such as Lake Erie are an important parameter in the design of shoreline water resources projects because they have a significant effect on the wave climate, currents, and lake levels, which in turn affect the amount of shoreline erosion and flooding that occur at the shore zone. Prevailing winds in the study area are from the west through southwest directions. Table B1 shows prevailing wind direction and mean wind speed by month. This table indicates that the maximum winds occur in the winter and spring. Figure B11 shows the wind rose of surface winds as measured at the Toledo Express Airport for the years 1932-1956. Based on these data, the wind is blowing offshore from the study area an average of 176 days per year. The significance of offshore winds is that they have little effect on erosion of the shoreline.

Figure B12 is a wind rose showing frequency and direction of overwater winds. These data were taken by vessels traversing the western end of Lake Erie. It should be noted that the data presented are biased towards the navigation season, with no observations from January through March when Lake Erie is normally closed to navigation because of ice cover.

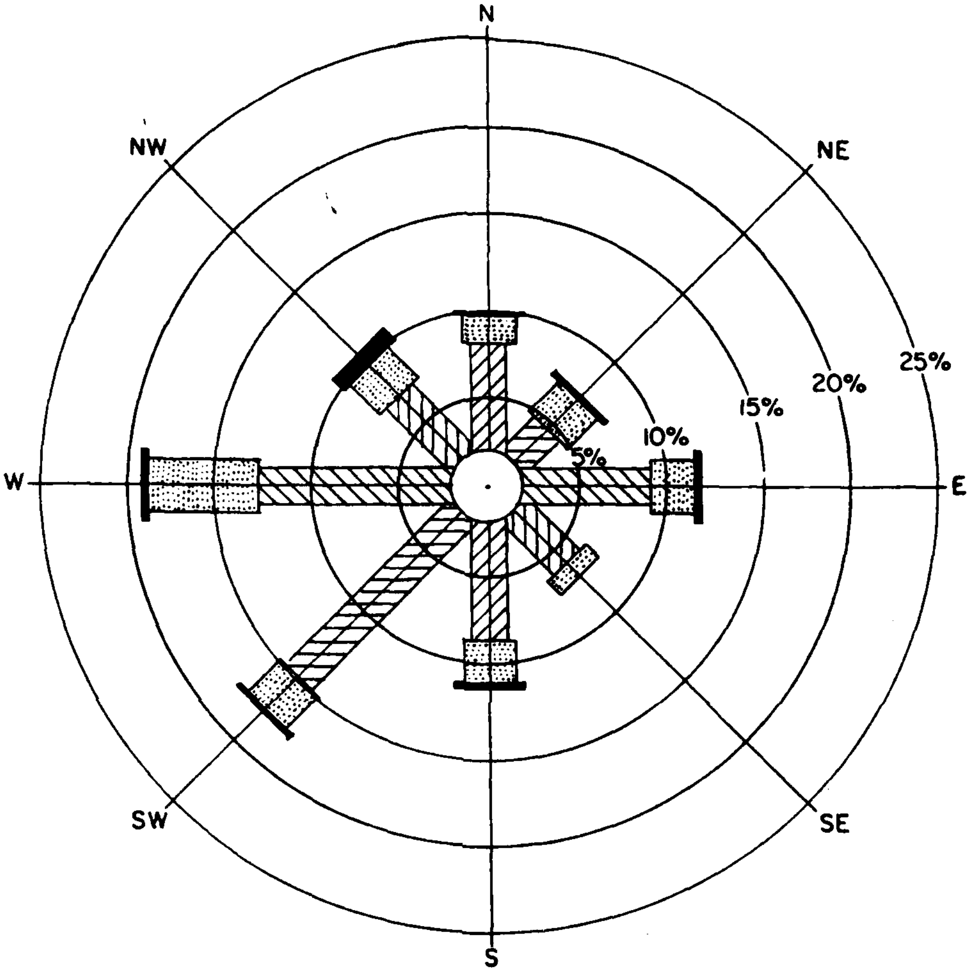
Shore damage in the study area is greatest when winds are out of the north, northeast, or east. Winds from these directions occur on the average of 98 days per year. However, speeds are seldom high; winds with speeds greater

Table B1 ~ Wind Data, Toledo, Ohio

Month	Mean Speed (mph)	Prevailing Direction	Fastest Mile*		
			Speed (mph)	Direction	Year
January	10.9	WSW	47	W	1972
February	10.9	WSW	56	SW	1967
March	11.0	WSW	56	W	1957
April	11.0	E	72	SW	1956
May	9.9	WSW	45	W	1957
June	8.4	SW	50	W	1969
July	7.5	WSW	54	NW	1970
August	7.3	SW	47	W	1965
September	7.8	SSW	47	NW	1969
October	8.7	WSW	40	SW	1956
November	10.2	SSW	65	SW	1957
December	10.4	SW	45	SW	1971
Record Length (years)	20	8	20	20	

* The fastest mile would be a wind gust with a duration of one-half to one and one-half minutes.

SOURCE: NOAA Climalotogical Data, Annual Summary, 1975



ANNUAL WIND ROSE FOR WESTERN LAKE ERIE

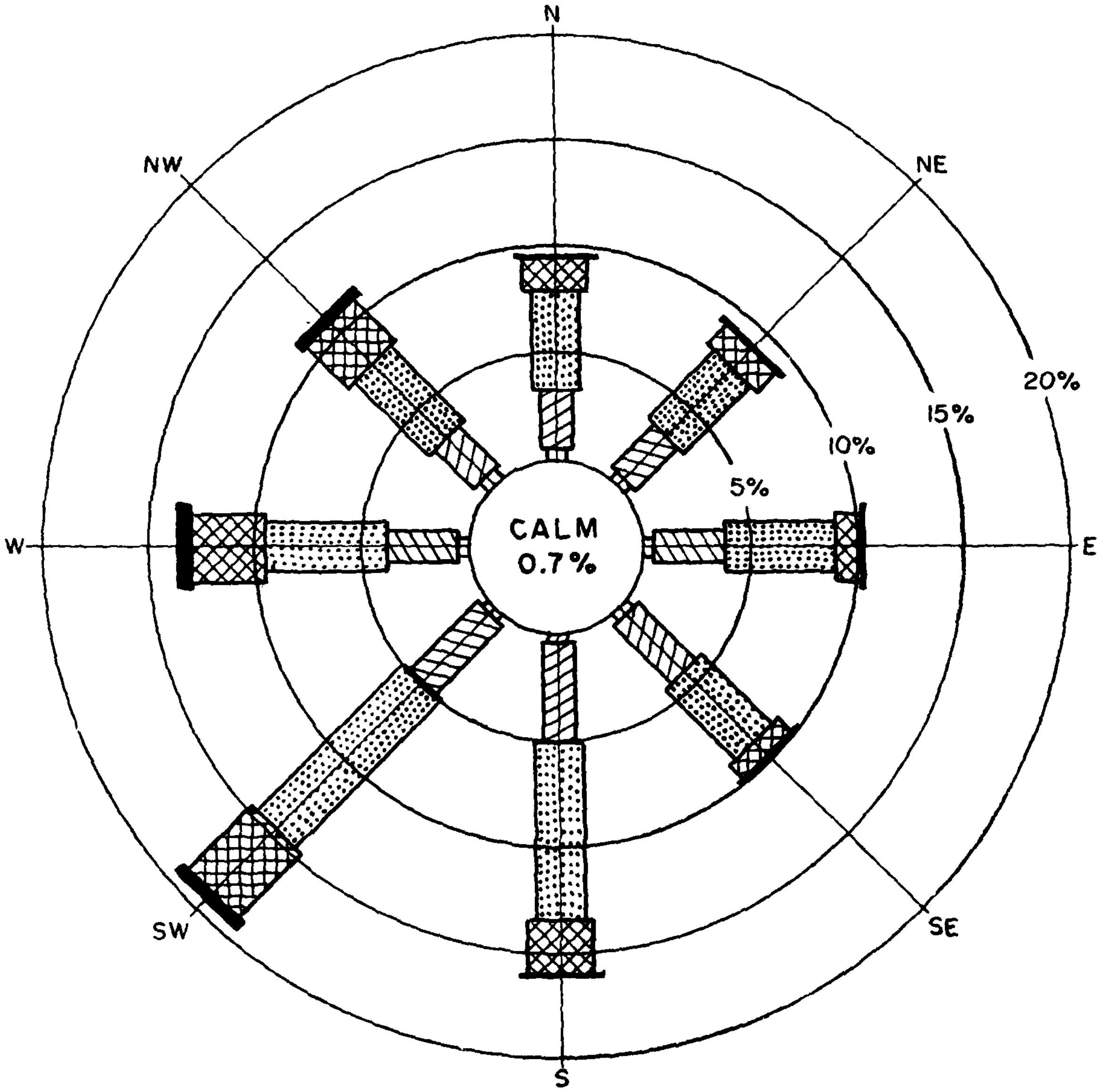
VELOCITY
(mph)

0 - 13
13 - 28
> 28

COMPILED FROM DATA OF U.S.
WEATHER BUREAU, TOLEDO, OHIO

BASE PERIOD: 24 YRS. 1932-1956

FIGURE B11



ANNUAL WIND ROSE FOR WEST LAKE ERIE
OVERWATER WIND

WIND SPEED
IN KNOTS

- 0 - 3
- 4 - 10
- 11 - 21
- 22-33
- 34-47

OVERALL PERIOD OF RECORD:
1960 - 1970

SOURCE:
"SUMMARY OF SYNOPTIC METEOROLOGICAL OBSERVATIONS FOR GREAT LAKES AREAS," VOLUME I. LAKE ONTARIO AND LAKE ERIE NOAA, NATIONAL CLIMATIC CENTER, JANUARY 1975.

FIGURE B12

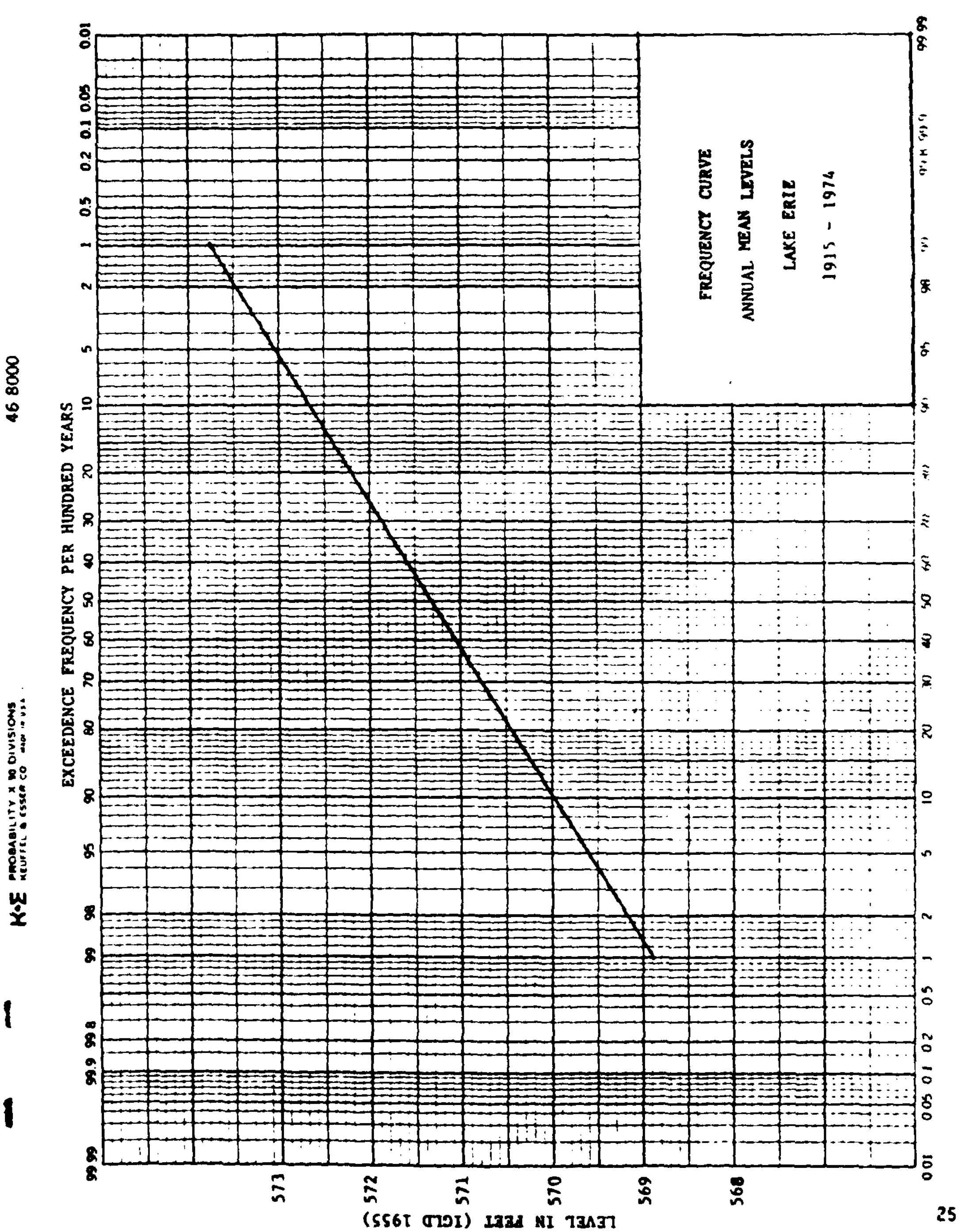
than 13 miles per hour occur on the average of 14 days per year, and winds with speeds greater than 28 miles per hour occur on the average of 2 days per year. The maximum velocity for a 5-minute period in the past 80 years was 65 miles per hour from the southwest on 21 March 1913.

7. Lake Levels and Fluctuations - The levels of the Great Lakes are based on the International Great Lakes Datum of 1955 (IGLD - 1955), and are referenced in feet above mean water level at Father Point, Quebec.

Periods of high lake levels are particularly critical along the shoreline because of accelerated erosion and more extensive flooding of low-lying areas during storm events. The levels of Lake Erie fluctuate on a long-term, seasonal, and short-term basis. On the long-term basis, the levels of Lake Erie are dependent upon the supply of inflow from the upstream lakes and the local supply from the Lake Erie basin, both being affected by the amount of precipitation over the Upper Great Lakes. Extended periods of high precipitation produce high levels, and vice versa. Since the magnitude and duration of precipitation are irregular, the periods of high and low lake levels do not occur in any regular cycle. The average level of Lake Erie is 570.6 IGLD - 1955, and the annual mean level has varied from a maximum of 572.71 in 1973 to a minimum of 568.05 in 1934. The stage-frequency curve of the annual mean levels for Lake Erie (Period of Record 1915-1974) is shown on Figure B13.

Seasonally, maximum Lake Erie levels occur in the summer, and minimums in the winter, as shown in Figure B14 below which was reproduced from the Detroit Districts' publication, Monthly Bulletin of Great Lakes Levels for December 1980. The levels in feet shown on the graph are referenced to the Chart, or Low Water, Datum of 568.6 (IGLD - 1955) for Lake Erie. From the graph, the seasonal levels have varied from a maximum of +4.9 feet above Low Water Datum (elevation 573.5 on IGLD - 1955) in June 1973 to a minimum of -1.1 feet below Low Water Datum (elevation 567.5 on IGLD - 1955) in February 1936, for a maximum monthly variance for the period of record of about 6 feet. The Stage-Frequency Curve of Annual Maximum Monthly Mean Levels at Toledo is shown on Figure B15. This curve is considered reasonably representative of the study reach although a slight difference in monthly levels between Toledo at the west and Marblehead at the east does exist.

Drastic short-term fluctuations in lake levels can be created by wind stress and barometric pressure changes on the lake surface. Wind setup and seiches can have a significant effect on lake levels, particularly at the eastern and western extremities of Lake Erie. For the study area, sustained winds blowing shoreward from the northeast tend to increase the water level, whereas westerly winds tend to reduce the water level at the shore. Lake levels at Toledo have ranged from 8.3 feet above the Low Water Datum (LWD) elevation of 568.6 to 7.5 feet below LWD in direct response to the effects of wind and seiches. An example of the wind effect on lake levels is shown on Figure B16 where a set-down of 9.3 feet below mean monthly Lake Erie level occurred at Toledo during April 1979. During this event, sustained high winds from the west through southwest produced the short-term low level at Toledo and the extremely high level at Buffalo, New York at the opposite end of the lake. Winds from the opposite direction produce the reverse effect on



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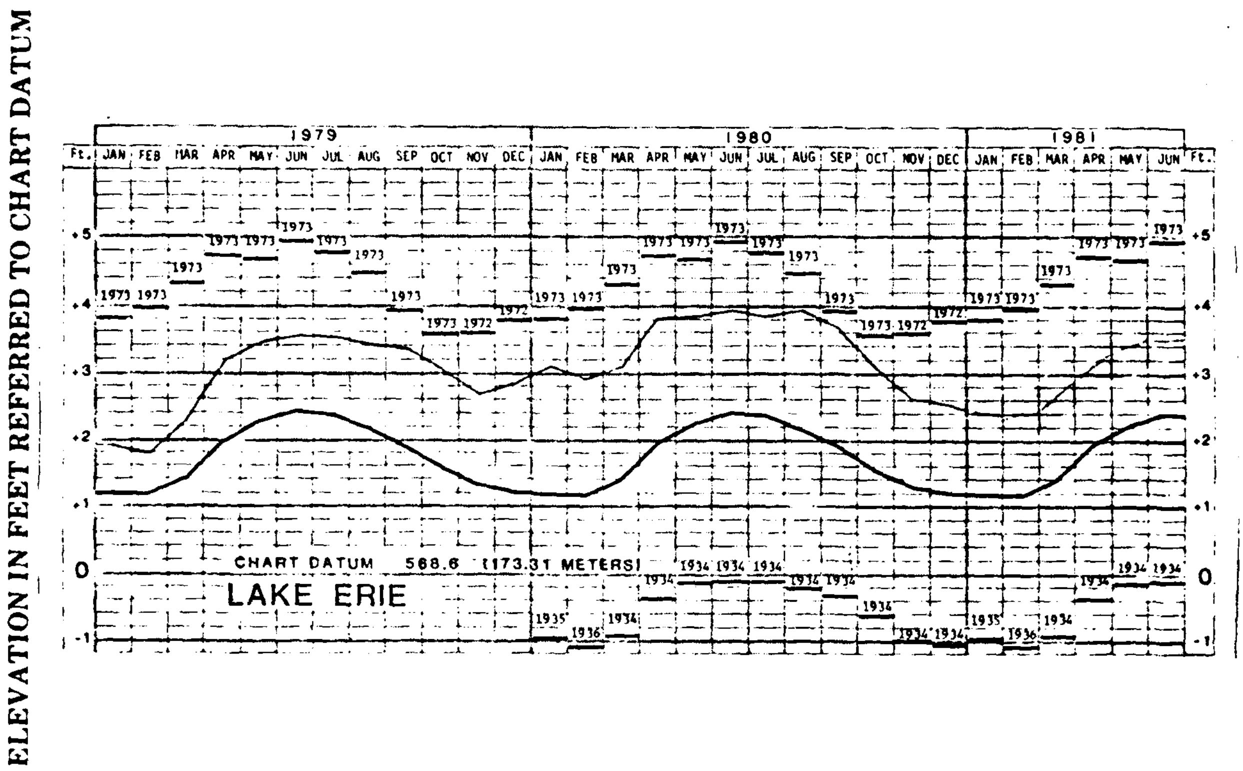
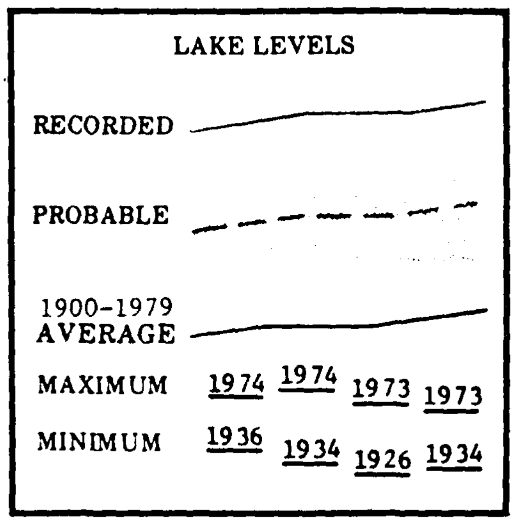
SOURCE: Standardized Frequency Curves for Design Water Level Determination on the Great Lakes, Detroit District, May 1979.

FIGURE B13



LEGEND



MONTHLY MEAN LEVELS
OF LAKE ERIE

FIGURE B 14

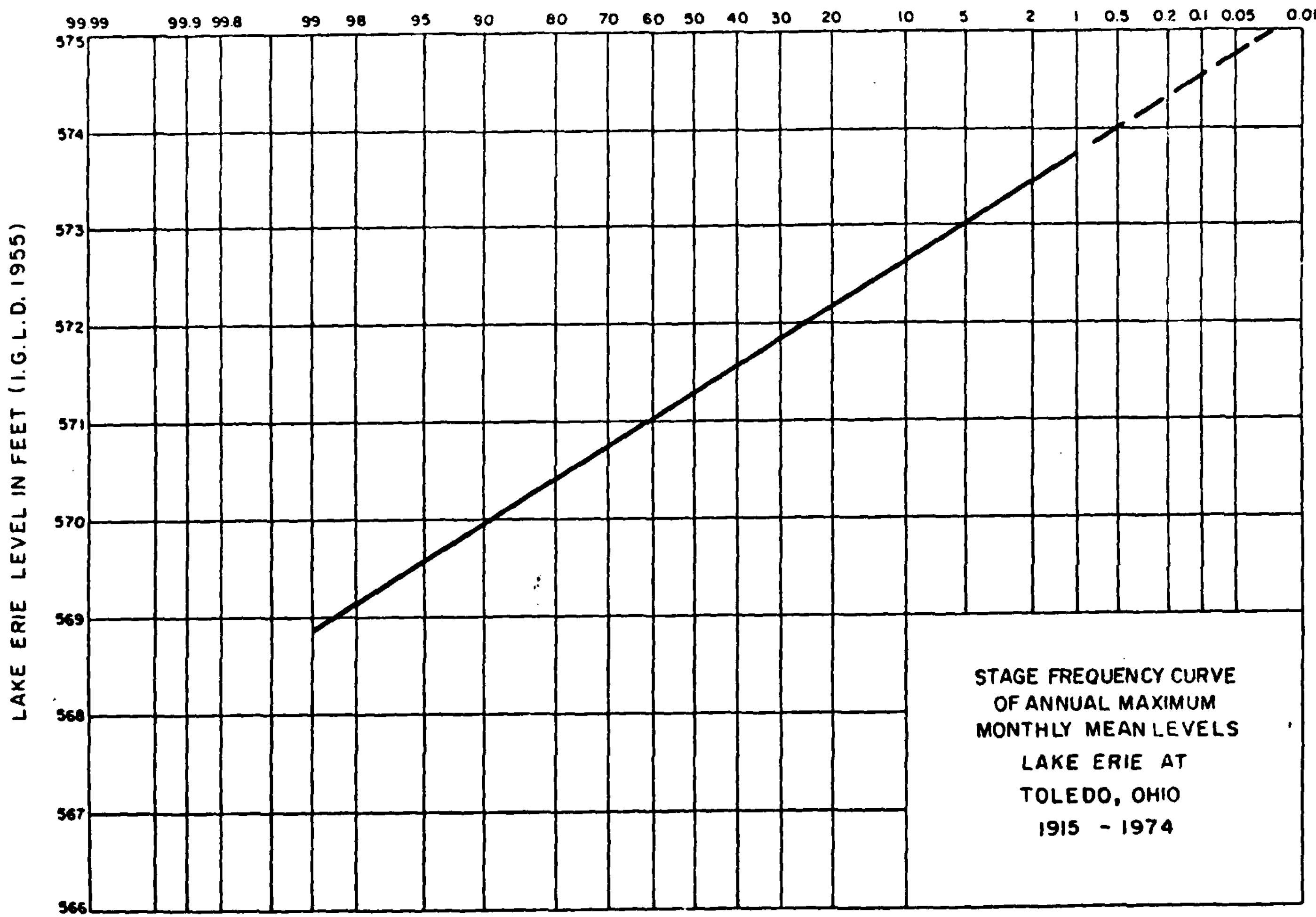


Figure B-15

SOURCE: STANDARDIZED FREQUENCY CURVES FOR DESIGN WATER LEVEL DETERMINATION ON THE GREAT LAKES. MAY 1979.

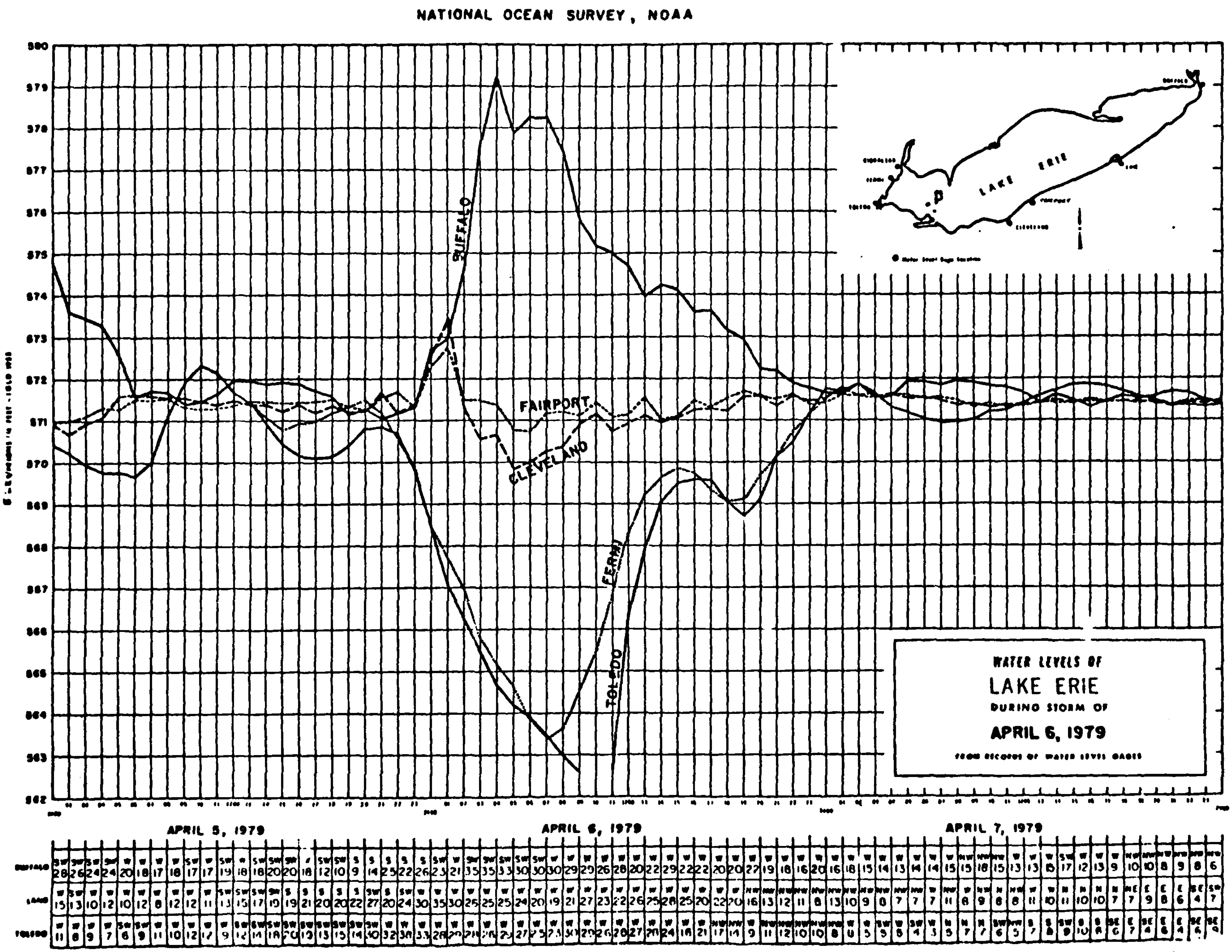

NATIONAL OCEAN SURVEY, NOAA
BUFFALO
FAIRPORT
CLEVELAND
FERMI
TOLEDO
LAKE ERIE
APRIL 5, 1979
APRIL 6, 1979
APRIL 7, 1979
WATER LEVELS OF
LAKE ERIE
DURING STORM OF
APRIL 6, 1979

Figure B-16

lake levels. Figure B17 is the stage-frequency curve of maximum instantaneous levels of Lake Erie at Toledo. This stage-frequency relationship for Toledo was used in the preliminary investigations for this Reconnaissance Report although stages for given frequencies at the eastern end of study area would be somewhat less than at Toledo.

8. Wave Climate - Local wind action is the main generating force for surface waves on the western end of Lake Erie. Wind velocity and duration, and the fetch of open water over which the wind blows, dictates the amount of wind energy transferred to the water surface. Although wave height is controlled by these factors of fetch and wind the wave climate experienced along the western Lake Erie Shore is greatly influenced by wind direction, offshore bathymetry, and shoreline geometry. The western end of Lake Erie is generally quite shallow and has an irregular shore which is dominated by islands, shoals, headlands, and embayments. The study area wave climate is highly variable through time and locality.

The islands located between Marblehead and Pelee Point form a barrier which isolates the study area from the long easterly fetch of Lake Erie, partially protecting some areas from easterly storms. Westerly storms do tend to exhibit the strongest winds of longest duration but for much of the study area there is no significant fetch for waves from the west to develop. Maumee Bay is exposed to waves from the northeast through east. The rest of the study area is exposed to storms from east through northeast and north to northwest.

Deepwater design wave conditions are presented in WES Technical Report H-76-1, "Design Wave Information for the Great Lakes, Report 1, Lake Erie" (1976) for five grid points within the study area. The 5, 10, 20, 50, and 100-year seasonal significant wave heights are hindcast from historical storm data for each grid point. Based on this data, wave heights are greatest during the winter months and least during the summer. Ten-year frequency waves of 8 to 9.5 feet are predicted for this study area but the shallowness of the western basin of Lake Erie is such that it is unlikely that waves of this height could reach the nearshore. The size of the design wave at any point along the nearshore will be controlled by the water depth.

9. Coastal Processes - The erosion and flooding situation along a given reach of shore is controlled by lake level, wave action, and associated current patterns shore and offshore topography and geology, availability of beach-building material, and the activities of man.

Lake levels vary from season-to-season and year-to-year in response to variations in the climate which control the inflows. Generally, spring water levels are the highest with a gradual lake level drop through the summer and fall to the lowest levels in the winter months. Long-term climatic variations cause periodic lake level cycles. For example, there was low water in the late 1930's, high water in the early 1950's, low water through the mid-1960's, and high water in the mid-1970's. Beyond these periodic variations in the quantity of water in the basin, there can occur oscillations in the water surface induced by barometric lows or long-term high velocity winds. These setups or seiches will "pile" water up toward one end

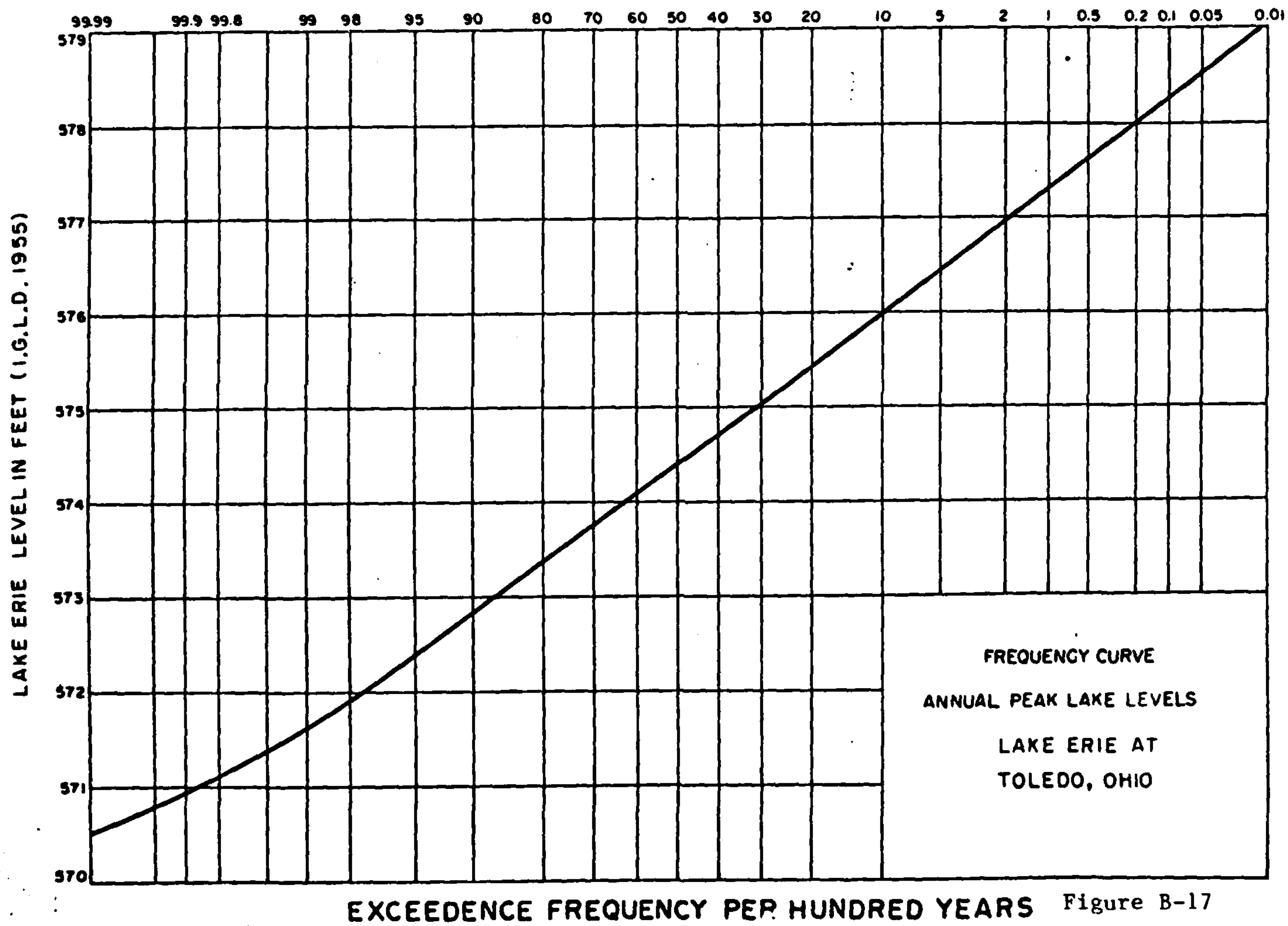


Figure B-17

SOURCE: STANDARDIZED FREQUENCY CURVES FOR DESIGN WATER LEVEL DETERMINATION ON THE GREAT LAKES, MAY 1979.

of the lake causing an instantaneous short-term rise. The long-term monthly mean lake level will cause periodic changes in the shore erosion rate, however, it is the instantaneous setup which often cause inland flooding and disastrous property damage.

Most wave action of interest on the western end of Lake Erie is generated by winds blowing across the water's surface. The strength and duration of the winds and the water fetch (or length of open water over which the winds can blow without obstructions) control the deep water wave height. As these waves approach shore, the wave base feels the shallowing lake bottom and the wave begins to shoal and eventually break.

The direction of regional littoral transport is dependent upon the dominant wave climate. Western Lake Erie is within the prevailing westerlies, however, the greater exposure of open water is toward the easterly quadrants, therefore, the regional littoral transport is generally from east to west. However, the complex shoreline geometry results in a region which is characterized by local reversals and numerous nodal points. From the Michigan-Ohio border to the Maumee River the transport is characterized by a slight southern dominance although there is very little littoral material available. Along the southern shore of Maumee Bay the drift direction is very erratic and poorly defined. There is a convergence of the drift pattern at Little Cedar Point, with drift on both sides of the point toward the north. Between Reno Beach-Lakemont Landing and the Toussaint River mouth, the drift is from east to west. Between Camp Perry and the mouth of the Portage River, the drift is from west to east. The Marblehead and Catawba Island headlands are areas of littoral divergence with movement toward the south from Catawba Island and toward the west from Marblehead. The preceding discussion was inferred from local accretion patterns, erosion assymetry, and the deflection of stream discharge channels as observed in aerial photography and various topographic maps. Since the Western Erie Basin is such a poorly nourished littoral system, the apparent dominance of a local drift pattern may be highly sensitive to reversals and seasonal wave climate fluctuations.

The topography and geology of the shore and nearshore control the wave energy reaching the shore and the availability of beach-building materials. A shallow offshore area will greatly reduce the wave energy at the shore as the approaching waves break offshore. The presence of an offshore sand source, a river delta, or sand and gravel rich bluff material will supply sediment to the beach. There is a general deficiency of littoral material in western Lake Erie. The glaciolacustrine deposits which characterize much of the shore from Toledo to Port Clinton is a very poor source of beach-building material, principally because virtually all of these sediments are too fine and the height of bluff exposed to wave action is very small. The exposed bedrock bluffs of the Lake Erie Islands, Catawba Island, and Marblehead are also a poor source of littoral material other than limestone cobbles. There are some localized offshore sand deposits including a large sand shoal offshore of Little Cedar Point, a barrier beach complex and an offshore sand sheet in the East Harbor and West Harbor area, a broad sand and gravel deposit off of Locust Point, and a discontinuous narrow strip of sand parallel to the barrier beach shore of Crane Creek, Long Beach, Sand Beach, and Ottawa National Wildlife Refuge. These offshore sand areas appear to

represent more of a relict offshore sand sink than a modern source for onshore sand movement. The major rivers of this area are sluggish streams which travel over a low relief glaciolacustrine clay plain. All have drowned mouths which trap all but the very finest fraction of the suspended sediment load. Thus, the West Lake Erie river system is a negligible contributor to the littoral system. The quantity of beach-building material available from any and all sources is very limited in the study area. During later stages of this study, a more detailed sediment evaluation will be prepared to qualitatively evaluate the present sources and sinks of beach material and predict the effects of any alternative study recommendations.

The activities of man have influenced the coastal processes along many sections of shore. Groins and jetties block littoral transport causing updrift deposition and downdrift starvation while promoting offshore losses. Vertical structures frequently reflect wave energy offshore, causing scour and offshore losses. Revetments which protect areas of shore or barrier beach from recession may not cause overt damage, but they do upset the sediment budget by eliminating sections of shore as sources of sand and gravel. Any construction plan or operation practice which eliminates sediment sources for promotes sediment losses to the offshore will enhance erosion. Any construction which manipulates the nearshore wave or current pattern may redistribute the erosion-deposition character of the shore.

10. Water Quality - The chemical content of the waters of the Western Basin of Lake Erie have changed markedly in the past 50 years. Intensive agricultural activities and industrialization of the Western Basin's watershed have greatly increased the nutrient and sediment load, which has led to an acceleration of the eutrophication process (nutrient enrichment) in the lake. The biological and chemical changes indicating eutrophy in the Western Basin include: large oligochaete and midge larvae populations in the benthos; high plankton abundance with blooms of blue-green algae; warmwater fish replacing characteristically coldwater fish; and increases in total dissolved solids, calcium, chloride, sodium and potassium sulphate, phosphorus, ammonia-nitrogen; and decrease in oxygen largely due to the increase in oxygen demand of the sediments. Historically, a vast macrophytic growth which occurred in the Western Basin has nearly disappeared; it has been replaced by an increased phytoplankton growth. The International Joint Commission's (IJC) annual report on Great Lakes water quality reported that since 1970 total phosphorus concentrations in the Western Basin have been increasing resulting in excessive algae growth and depressed oxygen levels. The report also cited mercury contamination of fish is also a problem in the Western Basin of Lake Erie.

With cultivation of the Great Black Swamp and consequent transport of the erodible soils into the lake, there has been a large increase in turbidity. Western Lake Erie, particularly Maumee Bay, can become quite turbid since much of the bottom sediments are silts and clays and are within the zone of wave action. The bedrock areas of the Western Basin in the vicinity of the lake islands tend to remain somewhat more clear due to the lack of fine sediments and slightly deeper water.

Table B2 presents a summary of ambient Lake Erie water quality data obtained from the U. S. Environmental Protection Agency's STORET system. The Lake Erie nearshore area, from the tip of Cedar Point to Wards Canal and from Camp Perry to Marblehead, is designated Exceptional Warmwater Habitat, Public Water Supply, Agricultural Water Supply, Industrial Water Supply, and Bathing Waters and must meet the standards set forth by the Ohio Environmental Protection Agency (OEPA). Therefore, the standards presented in the table represent the most stringent associated with each use designation. Maumee Bay, the Lake Erie shore from Wards Canal to Camp Perry (Magee Marsh area), and a small area between the Port Clinton Harbor jetties are excepted areas and are designated for Warmwater Habitat, Agricultural Water Supply, Industrial Water Supply, and Primary Contact Recreation. These areas will meet the most stringent standards for those uses.

The available data shows that high zinc levels occur along the entire study shore, with 67 percent of the sampling sites recording levels above OEPA standards. High cadmium and mercury levels were recorded from Locust Point to Port Clinton while high iron content occurred from the Maumee River to the mouth of the Toussaint.

Water quality standards for State of Ohio beaches required that the following conditions be met:

> Geometric mean fecal coliform content, based on not less than five samples within a 30-day period, shall not exceed 200 per 100 ml, and shall not exceed 400 per 100 ml in more than 10 percent of the samples taken during any 30-day period.

Table B3 presents the current status of Western Lake Erie beaches with regard to State standards.

Table B2 - Chemical Analysis of Nearshore Western Lake Erie Water Quality

Water Quality Parameter	Maumee River at Mouth (excepted area)	Lake Erie at Toledo (excepted area)	Maumee Bay Near Tip of Cedar Point (excepted area)	Lake Erie North of Cooley Creek	Between Wards Canal and Crane Creek (excepted area)	Lake Erie Standards	
							Excepted Areas
Ammonia (mg/l)	-	-	-	-	-	6.5	13.0
Arsenic (mg/l)	0.0001	-	-	-	-	0.05	0.1
Barium (mg/l)	0.16	0.067	-	-	-	1.0	-
Beryllium (mg/l)	-	0.0	-	-	-	1.1	0.1
Cadmium (mg/l)	0.001	0.0	0.0004	0.0008	0.0004	0.0012	0.002
Chromium (mg/l)	0.005	0.003	0.026	0.05	0.021	0.05	0.1
Copper (mg/l)	0.008	0.0	0.009	0.003	0.011	0.005	0.5
Dissolved Oxygen (mg/l)	9.1	-	11.9	12.0	11.4	>6.0	>4.0
Fluoride (mg/l)	0.45	-	-	-	-	1.8	2.0
Iron (mg/l)	2.26*	0.316	2.74*	1.24*	2.194*	1.0	1.0
Lead (mg/l)	0.102*	0.0	0.003	0.004	0.002	0.03	0.03
Manganese (mg/l)	-	0.0	0.079	0.057	0.042	0.05	-
MBAS (mg/l)	0.17	0.45	-	-	-	0.5	0.5
Mercury (mg/l)	0.0	-	0.00002	0.00003	0.00003	0.0002	0.0002
Nickel (mg/l)	0.0	0.0	0.02	0.012	0.014	0.025	0.2
Nitrate-N (mg/l)	3.7	1.35	-	-	-	10.0	-
Nitrate + Nitrite (mg/l)	5.3	-	-	-	-	100.0	100.0
pH	7.6	7.5	8.5	8.1	8.1	6.5-9.0	6.5-9.0
Phosphorus (mg/l)	0.24	-	-	-	0.99	1.0	1.0
Selenium (mg/l)	0.0	-	0.001	0.003	0.0009	0.01	0.05
Silver (mg/l)	0.0	0.0	-	-	-	0.05	-
Zinc (mg/l)	0.022	0.05*	0.059*	0.34*	0.199*	0.03	0.04

Table B2 - Chemical Analysis of Nearshore Western Lake Erie Water Quality (Cont'd)

Water Quality Parameter	Toussaint River at Mouth (excepted area)	Davis-Besse Power Plant (excepted area)	Erie Industrial Park (excepted area)	Camp Perry (excepted area)	Port Clinton (excepted area)	Put-in-Bay	Kelley's Island	Lake Erie Standards	
									Excepted Areas
Ammonia (mg/l)	-	1.1	-	0.92	-	-	-	6.5	13.0
Arsenic (mg/l)	-	0.01	0.01	0.01	0.01	-	0.01	0.05	0.1
Barium (mg/l)	-	0.14	0.0	0.12	0.1	0.0	0.13	1.0	-
Beryllium (mg/l)	-	0.0	0.1	0.0	0.0	0.0	0.0	1.1	0.1
Cadmium (mg/l)	0.002	0.003*	0.003*	0.003*	0.003*	0.0	0.0	0.0012	0.002
Chromium (mg/l)	0.024	0.018	0.15*	0.018	0.023	0.0	0.003	0.05	0.1
Copper (mg/l)	0.054*	0.045*	0.03*	0.03	0.003	0.00[illegible]	0.125*	0.005	0.5
Dissolved Oxygen (mg/l)	11.9	-	-	10.2	-	-	-	>6.0	>4.0
Fluoride (mg/l)	-	-	0.16	0.13	0.14	-	-	1.8	2.0
Iron (mg/l)	1.89*	0.022	0.295	0.144	0.017	0.368	0.126	1.0	1.0
Lead (mg/l)	0.003	0.003	0.003	0.003	0.003	0.002	0.005	0.03	0.03
Manganese (mg/l)	0.061*	0.018	0.03	0.018	0.018	0.0	0.02	0.05	-
MBAS (mg/l)	-	0.075	0.05	0.08	0.037	0.0	0.0	0.5	0.5
Mercury (mg/l)	0.0001	0.0005*	0.005*	0.005*	0.0005*	-	0.0005*	0.0002	0.0002
Nickel (mg/l)	0.033	0.0	-	0.0	0.0	0.0	0.0	0.025	0.2
Nitrate-N (mg/l)	-	1.1	1.36	0.92	1.0	0.45	0.3	10.0	-
Nitrate-Nitrite (mg/l)	-	-	-	0.25	-	-	-	100.0	100.0
pH	8.2	7.2	7.5	8.2	8.0	7.8	7.7	6.5-9.0	6.5-9.0
Phosphorus (mg/l)	0.1	-	0.0	0.04	-	-	-	1.0	1.0
Selenium (mg/l)	0.0008	0.005	0.01	0.006	0.007	-	0.005	0.01	0.05
Silver (mg/l)	-	0.018	0.0	0.018	0.015	0.0	0.02	0.05	-
Zinc (mg/l)	0.073*	0.14*	0.04	0.11*	0.023	0.165*	0.0	0.03	0.04

* Exceeds Ohio Environmental Protection Agency Standards.

Source: U. S. Environmental Protection Agency, STORET Inventory, August 1980.

Table B3 - 1978 Violations of State Water Quality Standards and IJC Water Quality Objectives at Western Lake Erie Beaches

Beach	Number of Times Where 5 Samples During a 30-Day Period Exceeded a Geometric Mean of 200/100 ml	Number of Values Exceeding 400/100 ml
Maumee Bay State Park (proposed)	0	0
Crane Creek	0	0
Camp Perry	0	0
Port Clinton	6	5
Lakeside	0	2
East Harbor	0	0

Source: Ohio Environmental Protection Agency, Ohio Department of Health, 1978.

11. Air Quality - Numerous substances are emitted into the air each year through human activities. Those substances which are added to the ambient air in quantities sufficient to cause harmful effects on humans are considered pollutants. At present, six substances whose effects are known to be harmful at concentrations above National Ambient Air Quality Standards (NAAQS) have been identified. These six are: Total Suspended Particulates (TSP); Sulfur Dioxide (SO_2); Nitrogen Dioxide (NO_2); Carbon Monoxide (CO); Photochemical Oxidants (Ozone); and Lead. These substances are referred to as Criteria Pollutants, that is, substances for which air quality standards have been adopted by the U.S. Environmental Protection Agency (USEPA).

In order to effectively deal with air pollution and attain NAAQS, the USEPA, with input from local governments and the public, has divided the nation into areas called Air Quality Control Regions (AQCR). Boundaries for each region were set through consideration of air pollution levels, population densities, geography, and common meteorological conditions. With respect to this study, the western Lake Erie shoreline contains parts of the Toledo and Sandusky AQCR's.

Violations of short-term ambient air quality standards for 1978 are summarized in Table B4. This table presents, by pollutant and AQCR, information on the number of days air quality standards were exceeded. For Total Suspended Particulates, Sulfur Dioxide, and Nitrogen Dioxide, there are, in addition to short-term standards, standards based on annual average concentrations. Table B5 shows the high annual mean concentrations at monitoring sites in the subject AQCR's. Air pollution episodes are summarized in Table B6. Official air pollution alerts are not called for every day alert level concentrations are reached. An alert is not declared if local weather conditions favor dispersion within the next 24 hours. In these cases, a health advisory is issued to the public. It must be noted that air quality data presented in these tables was obtained from generally urban monitoring sites and a great portion of the study area is removed from many of the industrial and high density, transportation-related sources of pollution.

Table B4 - Number of Days in Which Short Term Air Quality Standards Were Exceeded 1978

AQCR	TSP 24-Hr. Obs.>260 ug/m^3	SO^2 3-Hr. Avg.>1300 ug/m^3	24-Hr. Avg.>365 ug/m^3	NO_2 Annual >100 ug/m^3	CO 8-Hr. Avg.>10 mg/m^3	1-Hr. Avg.>40 mg/m^3	Ozone 1-Hr. Avg.>160 ug/m^3
Toledo	3	3	6	-	1	-	58
Sandusky	47	-	-	-	-	-	-

Source: Ohio Air Quality 1978, Ohio Environmental Protection Agency

Table B5 - High Annual Mean Concentrations
1978

AQCR	TSP: Highest Annual Mean (ug/m³)	TSP: Ohio Air Quality Standards	SO^2: Highest Annual Mean (ug/m³)	SO^2: Ohio Air Quality Standards	NO^2: Highest Annual Mean (ug/m³)	NO^2: Ohio Air Quality Standards
Toledo	78	60	84	60	65	100
Sandusky	69	60	-	60	43	100

Table B6 - Air Pollution Episodes
1978

AQCR	County	Ozone: No. Days Over Alert Level*	Ozone: No. Official Air Alerts	TSP: No. Days Over Alert Level	TSP: No. Official Air Alerts
Toledo	Lucas	30	4(14)**	-	-

* Official alerts were not always declared due to a favorable dispersion forecast within the following 24 hours.

** Numbers in parentheses are total number of days in alert.

Source: Ohio Air Quality 1978, Ohio Environmental Protection Agency

12. Biological Environment - The following section is based upon investigations carried out by the East Lansing Area Office of the U.S. Fish and Wildlife Service. All plates, figures, and tables referenced in this discussion are included in the Preliminary Fish and Wildlife Coordination Act Report, Appendix E.

a. Major Habitats and Vegetation - Wetlands constitute a major habitat type of the Lake Erie area. These areas of high productivity support a myriad of biological communities and serve as concentration areas for various fish and wildlife species. The aquatic habitats in northeastern Ohio and the marshes along the shoreline of Lake Erie in northwestern Ohio have the greatest diversity of aquatic vascular plants in the State. Today, the Lake Erie wetlands along the Ohio shoreline form a discontinuous band. The dynamic character of wetlands makes it nearly impossible to accurately calculate wetland acreages at any given time. Current estimates for wetlands existing in Ohio vary greatly according to the time of year an inventory was made, management practices, lake levels, and degree of disturbance to wetlands by man, winds, storms, seiches, or other factors. An Ohio Coastal Zone Management (CZM) study estimated that over one-half of the wetlands that existed in Ohio in 1955 have been lost. The Ohio CZM staff has estimated that approximately 15,000 acres of coastal wetlands remain in Ohio. Less than 10,000 acres of wetlands are estimated to exist within the project area.

Figure 2 illustrates the location of significant wetlands of the southwestern Lake Erie-northwestern Ohio area. Tables 1 and 2 list wetlands of the southwestern Lake Erie area.

Of the few remaining marshes open to Lake Erie in the project area, Metzger Marsh State Wildlife Area is the largest. A small area, planned as part of Maumee Bay State Park and located immediately west of Cedar Point NWR, is presently an unmanaged open marsh. Other small areas of open marsh may exist in the floodplains of the streams and rivers in the area. The short-term productivity of these unmanaged marshes has been reduced over the last few years by the recent high lake levels, however, periodic inundation may be necessary to maintain the long-term productivity of marshes.

Many of the Lake Erie marshes are managed for waterfowl. Large areas of marshland have been diked off from the main waters of the lake, bay, and rivers. Through water control operations, water within the dikes may be maintained at any desired level according to waterfowl needs.

In one management scheme, flooding and drawdown practices alter normal plant succession to encourage the germination and growth of desirable forms of vegetation and exclude others according to migrating waterfowl needs. Marshes are drained in mid- to late May to favor the germination of smartweeds, Walter's millet, and rice-cutgrass. Subsequent reflooding in September then makes these dense stands of vegetation available to migrating waterfowl. This practice is commonly used at Magee Marsh State Wildlife Area, the Ottawa National Wildlife Refuge Complex, Winous Point Shooting Club, and Toussaint Creek State Wildlife Area.

Another management scheme in common use by private marsh owners and private shooting clubs is aimed toward the harvest of waterfowl. This management scheme involves the draining of diked marsh areas and then planting the area to corn or soybeans. After the crops are harvested in late August and September, the area is flooded, allowing migrating waterfowl to feed on the crop residue. A list of the common aquatic plants of the Lake Erie marshes is presented in Table 3 of Appendix E.

In addition to wetlands, other natural habitats found along the southwestern Lake Erie shoreline include sandbars, beaches, mudflats, fields, forests, and secondary growth areas. The sandbars, beaches, and mudflats in the study area are limited. The transport of sand has been impeded by the development of various shore structures. Shore structures trap the limited quantity of available sand in the littoral drift system and prevent sand accumulations in the downdrift areas. Shore protection efforts by land owners have further limited the development, accessibility, and availability of mudflats and beaches. Vegetation in these areas varies depending on the vegetation in immediate upland areas and may include any of the aquatics listed in Table 3 and pioneer or soil stabilizing species.

Fields abutting the shorelines in the project area may be cultivated or uncultivated and may be vegetated by hay, clover, alfalfa, corn, soybeans, and winter wheat. Grasses may include Kentucky 31, tall fescue, rye grass, timothy grass, red fescue, and other introduced species. Old, uncultivated

fields commonly support a wide variety of grasses and broad leaved herb species including Canadian thistle, goldenrods, asters, wild carrot, teasel, yellow sweet clover, and mustard species.

Mature forest habitats in the project area are limited. Dominant tree species include those which are common in bottomland and floodplain areas, such as white ash, elm, red maple, cottonwood, sycamore, birch, boxelder, and hackberry. These hardwoods are more tolerant of moist soil and swamp conditions. On well-drained land, oak-hickory associations including red oak, bur oak, white oak, shagbark hickory, black walnut, tuliptree, and ash may be prevalent.

Secondary growth areas are those areas which are typified by shrubs and brush thickets composed of honey locust, red-osier dogwood, sumac, wild plum, crabapple, hawthorn, choke cherry, witch hazel, hazelnut, blackberry, and wild grape. These secondary growth areas are common along forest edges, canals, and ditches.

Presently, one plant species, pinkweed (*Polygonum pensylvanicum L. var. eglandulosum*) is proposed as a Federally-endangered plant. Pinkweed, or Pennsylvania smartweed has been found in Ottawa County and is associated with damp and disturbed areas. The State of Ohio has proposed a list of threatened and endangered plant species; however, this list has not reached any official status to date. The Ohio Natural Heritage Program has indicated that numerous species located in Lucas and Ottawa Counties have been placed on the proposed Ohio list. A publication on rare and endangered aquatic vascular plants of Ohio has indicated that 33 aquatic plant species in Lucas County and 31 aquatic plant species in Ottawa County are considered either extirpated, endangered, or threatened.

b. Zoobenthos, Zooplankton, and Phytoplankton

Zoobenthos

The drastic environmental changes in Lake Erie have greatly changed the composition of the benthic fauna of western Lake Erie. Changes in the benthic community can be attributed to: (1) Siltation from erosion and dredging, (2) industrial and municipal wastes, (3) intensive agricultural practices, (4) stream and river rehabilitation projects, (5) misuse of persistent chemicals (DDT, TFM, PVC, PCB), (6) exploratory drilling for petroleum distillates, and (7) waste materials from mining operations. Low dissolved oxygen concentrations in 1953 virtually eliminated the *Hexagenia-Oecetis* (mayfly-caddis fly) community. The deepwater bottom fauna has since been dominated by oligochaetes and midges. The aquatic diptera population has changed such that present conditions favor the pollution tolerant Tanypodinae over the Chironomidae. Invertebrates recorded as being present in Lake Erie are listed in Table 11.

Early studies of Lake Erie benthos found a diverse community. During the 1930's, the significant taxa were Ephemeroptera (mayflies). The species composition of the benthic community began to change in the 1950's. The formerly abundant mayflies were reduced to less than one percent of their former

abundance by the 1960's. From 1929 to 1965, Oligochaeta (freshwater earthworms), Chironomidae (midges), Gastropoda (snails), and Sphaeriidae (fingernail clams) showed increases by factors of nine, four, six, and two, respectively. The most common groups of benthic animals in the western basin are, in decreasing order: oligochaetes, midges, molluses, nematodes, leeches, crustaceans, mayflies, and caddis flies.

Zooplankton

The total zooplankton biomass has increased drastically from the 1930's. The present zooplankton community is similar to the earlier community, but with these changes: (1) Limnocalanus macurus, a copepod, has become established, (2) Diaptomus siciloides, a euryhaline copepod, is increasing, (3) Bosmina coregonii, a cladoceran, has increased. An increase in the crustacean zooplankton, dominated by copepods and cladocerans has occurred in western Lake Erie. Daphnia sp. dominate in late spring and Boxmina sp. in late August. The number of copepods increased from 70,000 per cubic meter in 1939 to 126,000 in 1967. These changes are indications of eutrophic changes in the zooplankton community.

Phytoplankton

The changes in the phytoplankton of western Lake Erie since 1929 have been described in many studies. Changes in phytoplankton have not been as dramatic as in the benthic fauna. Microcystis has replaced Aphanizomenon and Oscillatoria as major constituents of the blue-green algae. Filamentous algae, not previously reported in significant quantities, now appear in large numbers. A striking increase in the number of dinoflagellates, Ceratium hirundinella and Peridinium, which occurred only rarely in the past, has resulted in their becoming a major component of the plankton community. Phytoplankton changes have occurred from 1929 to 1963 as follows: (1) A three-fold increase in phytoplanton biomass (especially blue-green and green algae), (2) spring and fall maxima have increased in length and impact, and the minima have become shorter and less pronounced, (3) Melosira binderana, an algae of eutrophic waters, comprised up to 90 percent of the plankton at times, replacing Asterionella as the dominant spring diatom. Fall dominance has shifted from Synedra to Melosira to Fragillaria. Blue-green algae blooms appear in late July to early August as floating mats on the water.

Changes in the species composition and the population density of the various plants and animals in Lake Erie have occurred at a tremendously accelerated rate. Although the mechanisms of these changes are not documented and qualitative information on the ecology of zooplankton and phytoplankton is lacking, cultural pollution and eutrophication are generally named as the causes of these changes.

Areas with the greatest tendency to become anaerobic are inshore waters near cities and the bottom portion of the open water. The central basin has a more critical oxygen depletion problem than the western basin due to its tendency to stratify. Low dissolved oxygen levels in the western basin were first reported in 1930 (0.78 ppm). Oxygen depletion in the central basin now becomes so severe in summer months that large areas become anoxic and in the

western basin depressed dissolved oxygen concentrations are not uncommon. Oxidation of the large organic load in Lake Erie during periods of low circulation causes the low oxygen conditions so unfavorable for the obligate aerobic benthic fauna. Changes in phytoplankton populations have been related more to the changes in micronutrient or organic compounds as a result of pollution. Since these materials are continually recycled in the shallow waters of the western basin, it is unlikely that pollution control would show an immediate affect.

The delicate ecosystem of a lake bed is readily destroyed by smothering with even a thin covering of sand, clay, or silt. Silt can coat submerged aquatic plants and prevent photosynthesis. The once diverse aquatic vegetation in Lake Erie sheltered many organisms and tended to aid in clarifying waters and in preventing excessive phytoplankton blooms, which occur commonly today. The lake bed provides breeding and nesting areas and shelter for many species of plants and animals. The effects of its degradation are evident throughout the entire food web.

c. Fish

Utilization and alteration of the Lake Erie shoreline continue to increase with obvious impact upon water quality, substrate, and resident animal life in the nearshore waters. Information on nearshore fish communities and their seasonal habitat associations is generally lacking, but is needed to provide criteria for future shoreline development least destructive to the fish communities. Currently, the Ohio Department of Natural Resources, Division of Wildlife, is conducting a study of Ohio's Lake Erie shoreline fish communities. The objective is to determine the distribution and relative abundance of juvenile and adult major sport fish and their seasonal associations with each of the major shoreline habitats. A study of this magnitude requires a major effort involving prolonged and intensive surveying techniques such as electrofishing, gill netting, and seine sampling during all seasons and at all hours. This study should provide the kind of data essential for improved planning of coastal projects so that fish communities need not decline nor their relationships to one another change because of habitat loss.

This section provides a review of available data pertaining to the fisheries of the nearshore area in western Lake Erie from Maumee Bay eastward to the Bass Islands region. Fish are distributed along the shore according to depth, bottom type, cover availability, temperature, and water quality. Since the western basin is not uniform in these characteristics, the dimensions of the nearshore zone, relative to fish, are not precise. For purposes of this report, the nearshore zone includes the shallows near the shore, offshore reefs and shoals, and the estuarine lower courses of the tributaries within the study area.

For the past 200 years, the activities of the continually increasing human population surrounding Lake Erie have radically changed the fish communities and their habitats. Intensive and selective commercial fishing, watershed and shore erosion, nutrient loading, invasion of new species via canals, stream destruction, and wetland drainage are some of the stresses that have

been imposed upon Lake Erie. Since the beginning of the century, basic lake fertility has increased, striking changes have occurred in the density and species composition of phytoplankton, summer oxygen deficits have progressively increased, and the benthos of the western basin has completely changed. Deep, oxygenated coldwater areas, vegetated areas, clean bottom sand and gravel areas, estuaries, and wetlands have been considerably reduced in size since 1850.

The loss and degradation of these habitats used for spawning, nursing, feeding, migration, overwintering, resting, and refuge have reduced the diversity of the Lake Erie fishery. Many valuable commercial fish species such as lake trout, lake herring (cisco), lake whitefish, sturgeon, blue pike, sauger, and walleye have fluctuated and declined while other less valuable (less marketable) species such as carp, goldfish, and gizzard shad have appeared and proliferated. The current estimated species ranking in terms of biomass for Ohio waters of Lake Erie is headed by shiners and gizzard shad, neither of which are harvested commercially.

Although Lake Erie is the smallest of the Great Lakes, the annual commercial harvest is about 50 million pounds, nearly 40 percent of all the Great Lakes commercial harvest. This high productivity has been attributed to Lake Erie's shallow, fertile, warmer waters. Lake Erie biological production is at an all time high, but fish production has been directed to species considered "second rank" before 1900, when commercial production of salmonids was still high.

It has been estimated that 138 species of fish representing 24 families and 55 genera have been present in Lake Erie and its tributaries. Forty-three of these species are limited to tributaries and inland lakes, ponds, and wetlands and 95 are lake species. About one-fifth of the lake species were either introduced and did not become established or were native species which have become extirpated from Lake Erie. Over one-third of the rest of the lake species are considered rare. A "rare" species is defined as one recorded only once or very infrequently, and invariably in small numbers. This leaves less than 50 species which with intensive sampling can be currently found in Lake Erie. These 50 species are considered at least "uncommon." "Uncommon" is defined as a regular occurrence of a species in collections, but usually in small numbers. Table 15 lists 82 historic and current species found in the nearshore zone, their relative abundance in Lake Erie, and their relative utilization of the nearshore zone. These 82 species make (or made) some use of the nearshore zone at some time during their life cycles.

Habitat associations, distribution, and relative abundance of fishes found in the nearshore zone are not uniform and not always predictable. Species or groups of species can be restricted to one or more habitat types, or, they are tolerant of many different types of habitats and are not so restricted. Since habitat preferences of most Lake Erie fish species are known, the occurrence and relative abundance of most species in a previously unsampled area can be predicted with some degree of accuracy.

Lake Erie habitats are basically of two types: sheltered or unsheltered from wave action. Unsheltered habitats are beaches or bluffs directly subject to constant or intermittent wave action. Few coastal areas are totally sheltered except for narrow inlets, estuaries, man-made harbors, and areas protected by barrier reefs or bars. Nearshore areas near projecting peninsulas, points, or man-made structures can at times be sheltered habitat, but a shift in wind direction can change the habitat to an unsheltered type.

The Lake Erie unsheltered nearshore areas are extensive, but do not support a diverse fish fauna. Cover and vegetation are minimal and the hard bottoms are bedrock, cobbles, boulders, gravel, sand, or hard clay. Species which are common to abundant in exposed habitats are listed in Table 32. Species common to abundant in unsheltered areas with some amount of structure present such as reefs, boulders, riprap, and land projections to the windward are listed in Table 33. These structures provide some cover and interrupt waves. Species once common in unsheltered nearshore habitats but not depleted because of overfishing or siltation of clean sand or gravel bottoms are listed in Table 34.

The western basin has most of the sheltered nearshore habitats (inlets, estuaries, harbors, wetlands, areas protected by barrier bars) in Lake Erie. The diversity of habitats and species is great. Sheltered nearshore habitats are classified as: (1) Vegetated or unvegetated, (2) hard bottom or soft bottom, (3) lentic or lotic. Most species found in unsheltered habitats can also be found either perenially or seasonally in sheltered nearshore waters. Seasonal species are the most abundant during spring and early summer when they seek shelter for spawning. These seasonal species are listed in Table 35. Channel catfish, white bass, sauger, walleye, yellow perch, and freshwater drum generally remain in sheltered waters throughout the year while the abundance of other species is highly seasonal.

Species perennially common in sheltered habitats are those generally associated with aquatic vegetation. Vegetation-dependent species which need clean sand or gravel bottoms are the lake chubsucker and the tadpole madtom. Vegetation-dependent species which tolerate a variety of bottom types, provided turbidity is minimal, are listed in Table 36. Species not largely dependent on vegetation but common in shallow turbid waters with soft bottoms and abundant vegetation are carp, goldfish, gizzard shad, white sucker, black bullhead, and white crappie. Species not dependent on vegetation, but often associated with aquatic vegetation in clear, shallow water with sand or gravel bottoms are listed in Table 37.

Sheltered, unvegetated nearshore waters support a variety of fish species. Species tolerant of many bottom types and turbidity levels and therefore common in most all sheltered areas are listed in Table 38. Other species prefer clearer waters and harder bottoms such as sand, gravel, or clay (Table 39). These species may be found in both lentic and lotic waters. Carp, goldfish, bigmouth buffalo, black bullhead, and flathead catfish prefer soft bottoms of mud or muck.

Many species are abundant in both sheltered and unsheltered nearshore waters (Table 40).

All other Lake Erie species generally occur in one or two specific habitats. Keep in mind, however, that many species occupy a wide range of habitats and can be found in habitats to which they are not normally ascribed. Fish species will, however, reach their greatest abundance in only one or two types of habitat.

Although habitat associations of nearshore fishes are known and general groupings of species in particular areas or habitats are identifiable, this is only a general knowledge of associations and not of interactive relationships between species. Research in the area of interspecific relationships of nearshore fishes is lacking. Food habits studies have been conducted, but future studies will require greater intensity and duration to actually identify inter-relationships.

A table of habitat types used by Lake Erie fish species for spawning, nursery, feeding, migration, and overwintering has been compiled. Below each type of habitat is a list of fish species known to use that habitat. It can be inferred from this table the numbers and species of fish utilizing each particular habitat. This same information is also presented differently so as to determine whether a species is listed under several types of habitats or is solely dependent on one type for any particular use. These very useful tables are duplicated in the Preliminary Fish and Wildlife Report as Tables 41 and 42.

When determining the importance of a certain habitat type to a particular species, i.e., "determining critical fisheries habitat," the following questions should be asked: (1) Is the habitat critical in one or all phases of that species' life cycle? (2) What is the quantity or availability of that habitat? (3) How many species depend on this habitat? (4) How sensitive is this habitat to environmental alterations? (5) What is the biological, sociological, or economical importance of the species? A habitat type can be classified as more or less "critical" depending on the answers to the above questions. On Plates 1a, 2a, 3a, and 4a, the location and extent of each of the habitat types listed in Tables 41 and 42 are delineated.

The Ohio Department of Natural Resources, Coastal Zone Management Program (1979), indicates important fish habitat areas of Lake Erie as including all nearshore areas out to a depth of 20 feet, bays, estuaries, and offshore shoal areas. Five western basin habitat areas of critical concern are: (1) Maumee Bay, (2) Touissaint-Locust Point reef complex, (3) the islands area, (4) Ruggles Reef complex, and (5) Sandusky Bay (including Muddy Creek Bay).

Endangered Fish Species. Siltation, wetland diking and draining, tributary obstruction, and overfishing are considered the principal contributing factors in the depletion of the species now listed as endangered. Table 15 indicates which species are officially protected by law in Ohio. No fish on the Federal (U.S. Department of the Interior) Endangered Species List are generally found in the Lake Erie nearshore zone. The State endangered species found in the nearshore zone are rare lakewide, except the burbot, which is considered common in the deeper waters of the central and eastern basin. It is protected in Ohio because it is so infrequently found in the shallower waters.

The muskellunge, blacknose shiner, pugnose minnow, banded killifish, and Iowa darter are Ohio endangered species dependent on clear waters and abundant aquatic vegetation. The silver lamprey, lake sturgeon, mooneye, and longnose sucker, also endangered, are dependent on clear water and unobstructed tributaries for spawning.

d. Amphibians and Reptiles - The study area falls within the range of 19 species of amphibians and 22 species of reptiles. The amphibian list includes one mudpuppy, one newt, seven salamanders, two toads, and eight frogs. The reptile list includes one skink, seven turtles, and 14 snakes. Due to the isolation and size of the islands, only 10 species of amphibians and 14 species of reptiles are listed as occurring on the Lake Erie Islands. Table 51 lists the amphibians and reptiles of the southwestern Lake Erie along with their respective habitat preferences.

Among the reptiles occurring along the southwestern Lake Erie shore and islands, a few species are noteworthy of special mention. Ohio's population of Blanding's turtle is limited to the northern counties along Lake Erie, where it inhabits the marshy shorelines, inland streams, and wet meadows. The Lake Erie water snake is a subspecies of the widely-distributed northern water snake. The Lake Erie subspecies is similar to its relative, except that the dark pattern of crossbands is very pale or completely lacking. These snakes are limited to the islands of Lake Erie near Put-in-Bay and are abundant on the undeveloped islands. The eastern fox snake has a distribution limited to the Lake Erie islands and the southwestern shore of Lake Erie west of Sandusky.

e. Birds - The southwestern Lake Erie area has a diverse avifauna. A list of 267 birds for the Ottawa National Wildlife Refuge Complex is fairly representative of the birds which may be found in the southwestern Lake Erie area. Table 52 reproduces this bird list for Ottawa National Wildlife Refuge Complex. An additional 20 species of birds are listed as accidentally occurring in the area. Of the 267 species, approximately 33 speices, or 12.4 percent, can be considered permanent residents. Approximately 85 additional species, or 31 percent, nest but do not winter in the area. The remaining 149 species, or 55.8 percent, are either spring and fall migrants or winter visitors. Approximately 165 of the 267 species are typical of upland habitats. The remaining 102 species are generally found in open water, shoreline, marsh, or riverine situations.

When most of northwestern Ohio was unsettled, the dominant birds must have been those of forest and marsh - the dominant habitats. With the clearing of forests, these species declined in numbers, but were replaced with an increase in those species which could live in second-growth woods. Cultivation and agricultural practices created habitat for open field and meadow species. Finally, species which could adapt to man-made structures and environments also increased. On the other hand, many shorebirds, rails, ducks, and game birds declined as a result of the draining of marshes and

overhunting. The 1900's experienced a continuation of the decline of waterfowl and shorebirds until laws and stringent measures were implemented for their protection. Droughts in 1930 and 1935 further depressed waterfowl numbers. Certain songbird species have also declined due to the elimination of their natural habitats. More recently, pesticides and other environmental contaminants have been a factor in the decline of raptor and piscivorous bird populations.

Endangered Bird Species. Seven species of birds are on the State endangered species list. Table 53 provides a list of State endangered bird species which have been known to occur in the southwestern Lake Erie area.

The American peregrine falcon, sharp-shinned hawk, and Kirtland's warbler are migrants through Ohio. The Ottawa NWR Complex records 90 use days in 1976 for the peregrine falcon, 2,850 use days for sharp-shinned hawk in 1977, and sighting of one Kirtland's warbler in May of 1976. Since all possible sources of sightings were not contacted, other sightings may have been recorded.

The king rail and bald eagle are known to breed within the study area. The Ohio-Lake Erie bald eagle population has been closely followed in recent years. Information on the king rail, however, is scarce.

The bald eagle once nested throughout the Great Lakes region and wintered along major waterways in the southern portion of the Great Lakes States. Populations have declined as a result of losses of habitat and various other activities, including the use of toxic chemicals. In Ohio, a small resident population of bald eagles exists along the western shore of Lake Erie. This small population is "holding on" in an area of marginal habitat. Severe winters and storms have resulted in the destruction of nests and eagle losses. Habitat lost through the development of shoreline areas and human disturbances are other major factors in the eagles' decline.

Transient bald eagles are occasionally found along Lake Erie during spring and fall migration. Migration movements have been noted from March 17 to April 16 and from August 31 to October 31 and from February to March and October to November. Also, there may be a late spring to early summer invasion of southern birds aside from these spring and fall movements. Staff members of Ottawa NWR Complex have noticed marked bald eagles which were traced to populations marked in Saskatchewan.

Eagles' nests have been found in the tops of tall trees within one mile of a major water body and fishery resource. Nests have been found on Ottawa NWR, Winous Point Marsh, Ottawa Shooting Club Marsh, Green Island, East Sister Island, West Sister Island, Kelleys Island, Rattlesnake Island, and privately-owned woodlots on the mainland.

The king rail is generally seen only a few times during a season. The king rail appears to prefer nesting along sedge borders of marshes. Water depth at nest sites ranged from 4 to 18 inches. There have been only a handful of known king rail sightings in any Lake Erie marsh within the last several years - the capture of downy young with adults in 1971, the notation of 30 use days by king rail in Ottawa NWR Complex in 1977, and one recent sighting at Magee Marsh.

The upland sandpiper was a numerous migrant through the area until the 1930's. Nesting and migrating populations of upland sandpiper has significantly decreased over the past 60 years. Ottawa NWR Complex notes 60 use days for upland sandpiper in 1977.

The common tern is a colonial nesting species and normally nests in the Great Lakes region during late May through mid-June. The common tern may attempt to renest if initial efforts are washed out. Colonies of common terns have been observed in 1976 and 1977 on a man-made island known as Toledo Harbor Dike. An estimated 77 nests were located on the island in 1976 and 283 nests on the island in 1977. Common terns have been noted historically as colonizers of sites in early stages of plant succession. Bare gravelly, sandy soils with sparse vegetation have been documented as the preferred nesting habitat of common terns. Observations show that common tern activities have little effect on vegetative succession. Therefore, as the vegetation naturally grows to taller heights and woody species replace herbaceous ones, common terns are forced out. Perennially bare and sparsely vegetated areas have been occupied by the larger colonies of common terns on the Great Lakes.

Evidently, common terns existed in greater numbers in the past than they do presently. The decrease in nesting numbers and near extirpation of the common tern was caused primarily by the herring gull which invaded the western Lake Erie region about 1945 and has since occupied most of the former nesting territory of this tern. Common tern nesting sites have also been known to have been invaded by ring-billed gulls and inundated by high water. Scarce habitat has sometimes forced common terns to nest on sandbars cut off by high water levels.

Waterfowl. The primary waterfowl nesting species found along southwestern Lake Erie of the dabblers, or puddle ducks, are the wood duck, mallard, black duck, and blue-winged teal. Summer waterfowl records from 1880 and 1930 for Winous Point showed that there was a relative scarcity of nesting ducks in these years. At least a few mallards, black duck, wood ducks, and blue-winged teal probably nested at Winous Point in both 1930 and 1932, and perhaps in 1880. In 1932, black ducks were found to be the most common nesting duck of the southwest Lake Erie regions, followed closely by the mallard. A fair number of wood ducks, about as many blue-winged teal, and an occassional pintail or shoveller could be expected to nest in the area also. By 1951, considerably more nesting mallards than black ducks were noted at several Lake Erie marshes while only black ducks nested on the Lake Erie islands. Despite the apparent shift in abundance from black duck to mallard, the most spectacular increase in abundance has been observed in wood duck populations.

The wood duck nests in natural cavities and in stumps of trees. The average cavity diameter is 10 inches and entrances averaged 6 inches in diameter for 58 occupied natural cavities studied in Ohio. Cavity bearing trees in Ohio are generally sycamore, beech, and elm trees. Nests are found closer to water areas and forest canopy openings than randomly selected cavity bearing trees. In addition to the nest site itself, the nesting area should include open water for courtship, loafing, male displaying, and sufficient food resources within one mile of the nest site.

Wood duck production in Ohio has been enhanced by Ohio Department of Natural Resources' wood duck nesting box program. In 1979, none of the 34 boxes in Lucas County were utilized, whereas 39 of the 137 boxes (28 percent) in Ottawa County were utilized. Approximately 54 percent of the boxes utilized in Ottawa County succeeded in hatching 199 eggs. Generally, the boxes are 30 percent successful in being utilized and low use figures for Lucas County are due to lack of maintenance of boxes or poor box site locations.

Hens will lead their broods to water the first day after hatching. Wood duck broods spend several weeks in and close to ponds or small streams gradually making their way to larger water bodies. These areas must have sufficient cover in the form of bank vegetation or emergent aquatic vegetation. Around the first of October, wood ducks begin to congregate in creeks and along streams. Principal habitats in Ohio at this time are buttonbush swamps or flooded timber lands.

The Bureau of Outdoor Recreation, ODNR, reports 0.5 wood duck broods per mile for the Maumee River from 1952 to 1971. Wood duck habitat along the Maumee River is considered good but not outstanding. ODNR reports a mean of 0.08 wood duck broods per mile for the Sandusky River from 1974 to 1977. Similar information for other streams in the study area is lacking.

Wood duck migratory routes to and from Ohio are difficult to delineate. No well defined migratory corridors are known. Presumably, most of Ohio's birds are produced here in Ohio and travel southward through various river courses to winter in coastal swamps.

The major Ohio dabbler duck nesting species besides the wood duck are the mallard, black duck, and blue-winged teal. Recent breeding population estimates along southwest Lake Erie for these species are lacking. Mallards and black ducks contributed up to 70 percent of 1951 to 1952 breeding waterfowl at Winous Point marsh. Mallard pair densities at Magee Marsh averaged 21 pairs per square mile from 1960 to 1964, black duck densities averaged 5.6 pairs per square mile, and blue-winged teal averaged 30.1 pairs per square mile.

The loss of wetlands has contributed to the loss of potential nesting habitat. On managed marshes, areas that are drawn down to provide feeding areas for waterfowl are unattractive to breeding pairs. Mallard, black duck, and blue-winged teal nesting habitat in Ohio is primarily associated with inland shallow fresh marsh, inland deep fresh marsh, and inland open fresh water wetlands.

Mallards and black ducks begin to establish nests in April through May. Blue-winged teal begin nesting about one month later than mallards and black ducks. Average clutch size is 6.03 eggs for mallard, and 8.86 eggs for teal. Nests are located along dikes, atop muskrat homes, and along marsh and cattail edges. Blue joint grass, sedge, goldenrod, barnyard grass, and cattail have been used as nesting cover. Mallard and black duck have located nests closer to water than blue-winged teal. Mallard and black duck nests were found within 9 yards of water while blue-winged teal nests were found as far as 50 to 70 yards from water. In general, mallards exhibit a wider range of

nest site locations; mallard nests have been found in field and in tree cavities. Mallard nests comprised 32.3 percent of total nests found on Magee Marsh in 1907; blue-winged teal nests comprised 65.J percent of total nests found in the same area. As noted in Table 60, mallard and black duck nests comprised 85 percent and blue-winged teal nests comprised 8 percent of total nests found on Winous Point in 1951 and 1952. In 1968, nest densities of 1.9 waterfowl nests per acre in 1967 and 2.2 waterfowl nests per acre were noted.

Currently, diving duck production in Ohio is nearly nonexistent. Redheads have been recorded as nesting in the Lake Erie marshes. Hooded mergansers are reported using wood duck boxes in some areas. In earlier times, abundant aquatic vegetation attracted canvasback and redhead ducks. However, increased suspended sediment loads from rivers, streams and canals, dredging operations, and the introduction of carp eliminated many areas of aquatic vegetation. Consequently, birds dependent on aquatic vegetation for food have also declined.

A Canada goose (Branta canadensis maxima) population has been established at Ottawa National Wildlife Refuge through a cooperative agreement between the Ohio Department of Natural Resources and the U.S. Fish and Wildlife Service. The goose population, now numbering approximately 3,500 birds, was started in 1967 by wing clipping certain individuals for 5 years. The young of the artificially-maintained resident population became imprinted to the surrounding area and formed the resident population which can be seen along the marshes of Lake Erie today.

Current data on waterfowl breeding populations and production along southwestern Lake Erie appears to be sketchy. Raw data and unpublished information on waterfowl breeding populations and production probably exist among the records and observations of various researchers and waterfowl management units. To date, this material has been unattainable and an updated picture of present waterfowl production is needed.

The best available information on southwestern Lake Erie waterfowl comes from research done in the 1950's and 1960's. Table 55 presents waterfowl territorial pairs which were observed on Magee Marsh from 1953 to 1964. Table 56 presents estimates of breeding populations of waterfowl in selectively chosen marshes by various researchers. Table 57 presents estimates of waterfowl nesting densities as computed from observations in various Lake Erie marshes by various researchers. Table 58 presents a comparison of waterfowl breeding population data and estimates for 1951 and 1952 in two different study areas by two different researchers. Tables 59 and 60 present 1951 and 1952 waterfowl nesting success and brood data for Winous Point.

As demonstrated in Table 58, care must be taken in using this data to make a generalization regarding the Lake Erie marsh areas. Obviously, marsh quality is not uniform and the 40-acres which can support four breeding pairs in one area can only support one pair in another. Also, since 1964, significant changes in marsh habitat make the use of this information difficult in attempting any estimate of current populations. On one hand, high lake levels and the significant reduction of wetland acreages in the northwestern Ohio area would suggest a reduction of breeding waterfowl populations. On

the other hand, recent repair of many dike systems and management practices on various waterfowl management areas suggest the possible improvement of habitat for waterfowl production. Until current data i^ ^ollected, compiled, and analyzed, up-to-date waterfowl breeding population information and production estimates for southwestern Lake Erie will be lacking.

Shorebirds. Shifts in shorebird populations have been noticed over the past 60 years. Species such as the short-billed dowitcher and stilt sandpiper have been observed with increasing frequency and in greater numbers than in the past, while declines have been noted in species such as the pectoral sandpiper, solitary sandpiper, and upland sandpiper. The exposed shore areas and mudflats where many shorebirds feed have become limited. High lake levels, shore erosion protection structures, and development have reduced the amount of available habitat. Changes in the benthic community and in other food resource bases may also be factors contributing to the declines. Before 1930, the piping plover annually nested on the larger beaches along the south shore of Lake Erie. In more recent years, only an occasional nesting pair has been reported. Today their former nesting habitat in Ohio is occupied by homes, swimming beaches, and picnic areas.

The Ottawa NWR staff noted that more mudflat areas in 1976 brought in more accidental and rare shorebirds. The Ottawa NWR staff noted peak numbers of shorebirds in May of 1977 and in the summer of 1978. Approximately 7,000 birds were recorded in the summer of 1978. As many as 3,000 birds use the mudflats along Lake Erie at one time.

Marshbirds. The Lake Erie marshes support populations of marsh birds including coots, gallinules, marsh wrens, rails, and bitterns. Declines in the least bittern, American bittern, king rail, Virginia rail, and common gallinule populations have been noted as a result of the destruction or decrease in the amount of acceptable habitat. Few studies are available on Lake Erie populations of marsh birds. Nesting populations of sora, Virginia, and king rails appear to be small. The highest nest density to be observed was 1.5 nests per acre. The greatest nesting success recorded for either Virginia rail or sora rail at Winous Point was 50 percent of the known active nests. Nesting success, considering all nests found, was 11 percent. In general, sora rails appear to vary their habits according to habitat availability more than king rails. Virginia and king rails appeared to be more selective in their food preferences and nesting sites.

A decline in the Lake Erie population of common gallinule was noted in the 1960's. Prior to the 1900's, 1198 ± 520 pairs of common gallinules were estimated for southwestern Lake Erie marshes. Common gallinules were found in 1,774 acres, or 14 percent of the 12,820 acres of Lake Erie marshes studied. Pair densities ranged from 1.8 ± 1.0 pairs per acre at Cedar Point marsh to 11.4 ± 2.0 pairs per acre at Navarre Marsh. Nesting success was approximately 66 percent.

Upland Birds. Quantitative information on the populations of various upland birds is generally not available. Some information on the harvest of certain game birds is available from the Ohio Department of Natural Resources. While this information may be used to obtain a rough idea of game populations in

certain areas of the State, the information generally spans too great an area to give any clear indication as to the dynamics of various bird populations along the Lake Erie shore and on the islands.

Changes in the composition of upland bird species have corresponded to habitat changes. The elimination of specific insects and utilization of sprays for the control of Dutch elm disease have resulted in declines of species such as wood pewee, red-eyed vireo, warbling vireo, and yellow warbler. Declines have also been noted in catbird, brown thrasher, house wren, song sparrow, downy woodpecker, nighthawk, and chimney swift. Dominant types today are American robin, blue jay, cardinal, flicker, mourning dove, common grackle, starling, house sparrow, and red-winged blackbird. The red-winged blackbird originally nested primarily in swamps, marshes, or other wet depressions. After 1920, the red-winged blackbird began increasingly to nest in fields which were planted in grains and forage crops, on dry hillsides, and other mesic to xeric situations. As a result of adapting to another abundant habitat type, the species greatly increased in numbers despite the draining of its former swamp nesting habitat.

Several exotic species were introduced in the early 1900's. Among these were gray partridge and ring-necked pheasant. Gray partridge, a grassland species, is uncommon in the Maumee Basin. Ring-necked pheasant was introduced along the Lake Erie shore counties and on the Bass Islands. Ring-necked pheasant habitat is considered to be of medium quality along the southwestern lake shore. Modern clean farming pratices have resulted in the decline of pheasant populations. The removal of brushy fence rows, weedy fields, winter cover, and crop waste have left little habitat and food for the ring-necked pheasant. The Ottawa NWR Complex staff estimated the ring-necked pheasant population utilizing refuge areas to be approximately 350 birds with 100 produced in 1975 and approximately 100 birds contributing to 26,000 use days on the refuge in 1977. The pheasant population on South Bass Island has multiplied to where it has become a nuisance to farmers and grape growers.

Bobwhite populations have declined since 1800. Bobwhite populations are currently very low. Like the pheasant, quail habitat quality is marginal due to clean farming practices; the lack of sufficient food and cover has resulted in an increase in bobwhite mortality during adverse weather. During the severe winters of 1976 and 1977, bobwhite numbers were drastically reduced throughout Ohio.

Woodcock populations along southwestern Lake Erie are also low. Woodcock habitat within the study area is limited and marginal in quality.

Colonial Nesting Birds. Several species of colonial nesting birds nest along the southwestern Lake Erie area and the Lake Erie islands. Table 62 presents a list of colonial nesting birds which may be found in the study area. The southwestern Lake Erie area supports close to 50 percent of Lake Erie's total population of colonial nesting birds.

Great blue heron and great egret nest in tall living or dead deciduous trees. The particular tree species is not considered as important a factor in nest

site location as is the tree's growth form. Herons may change the location of their nesting colony to take advantage of available trees. Nest sites are most frequently found near marshland feeding areas. Major feeding points for the West Sister colony of great blue heron and great egret range from Cedar Point near Toledo to the Erie marshes at the Michigan border. Great blue heron and great egret colonies near Sandusky feed along Muddy Creek, the Sandusky River, Metzger Marsh, Magee Marsh, and Darby Marsh. Accounts of several thousand herons and egrets feeding in these areas indicate the importance of these areas. Many of these areas are under protection of governmental agencies or private clubs, but others are privately owned and their future is uncertain. Open areas near the nesting site are important as staging areas where the young birds learn to fly without the harrassment and potential injury caused by marauding herring gulls. In some cases, the feces whitewash is strong enough to kill understory vegetation under nest trees; however, occasionally it has the opposite effect and stimulates vegetative growth as is the case on West Sister Island.

Great blue heron and great egret populations are presently considered stable. The Winous Point and West Sister colonies of great blue heron and great egret form the major portion of the Great Lakes population. In 1976, the great egret in the Great Lakes region was limited in range to the west end of Lake Erie including the West Sister Island colony and two colonies in the Detroit River and Lake St. Clair.

Black-crowned night heron prefer to nest and to roost in brushy areas. On West Sister Island, black-crowned night heron make use of small plum and hackberry trees. Black-crowned night heron habitat is threatened with reduction by vegetation succession, by erosion and flooding of brushy areas by high water, and by dike and levee construction.

Huge colonies of black-crowned night heron occurred throughout the 1940's and early 1950's on Middle Bass and North Bass Islands. Since then, these colonies have been greatly decimated. The cause has been attributed to the widespread, recent use of DDT and other insecticides or poisons which affect the breeding cycle of piscivorous birds.

The cattle egret is a species which is expanding its range throughout North America. Cattle egret nesting was not recorded in the southwestern Lake Erie area until recently when cattle egret nests were noted on West Sister Island. First observations of nesting cattle egrets were made in 1978 when approximately 20 nests were recorded. An estimated 13 nests were noted in 1979.

Herring gulls utilize two substrate types along southwestern Lake Erie for nesting habitat. One substrate is bare rock (granite, sandstone, or limestone) as found in parts of the Bass Islands of Lake Erie. The second type of habitat is heavy herbaceous cover. An example of this habitat type can be found on the Sandusky Turning Point, a detached breakwater in Sandusky Bay, the only man-made herring gull site in the U.S. waters of the Great Lakes and not within the study area.

Herring gull nesting efforts were very successful during 1976. Extremely early nesting by the majority of the population was noted in 1976. Hatching

occurred in the second and third weeks of May at the Sandusky Turning Point colony of Lake Erie. Normally, hatching begins in the second week of May and peaks in the third and fourth weeks of May at 45°N. latitude.

Herring gull populations appear to have stabilized at lower levels than previous years due to environmental contaminants. Many Great Lakes herring gull nesting sites have been invaded by ring-billed gulls. However, this is not apparent among Lake Erie colonial nesting sites, and many herring gull sites throughout the Great Lakes have not been invaded by ring-billed gulls. Herring gull populations at Rattlesnake, Starve, and Green Islands have not been invaded by ring-billed gulls as of 1977.

Ring-billed gulls appeared most succesful when nesting on substrates of heavy silt and high clay content or soils with high clay and organic content. The heavier soils support the type of cover vegetation which ring-billed gulls prefer. The vegetative cover separates the territories and permits greater nesting densities. The invasion of herring gull nesting sites and common tern nesting sites by ring-billed gull has been noted previously. The more aggressive, earlier nesting ring-billed gull excludes other species from using preferential nest sites.

Migration and Wintering Areas. The importance of the western basin of Lake Erie as a migrational area for birds has long been recognized by ornithologists. The western shore of Lake Erie lies within the path of several important migration routes. Branches of both the Atlantic and Mississippi flyways pass over the western end of Lake Erie as illustrated by two species - whistling swan and snow goose. Whistling swans follow the Atlantic flyway, passing over Lucas and Ottawa Counties while migrating between their wintering grounds at Chesapeake Bay and their breeding grounds in northwestern Canada and Alaska. Snow and blue geese migrate the Mississippi flyway, passing over Lucas and Ottawa Counties while migrating from Hudson Bay to the Mississippi River Delta. A heavily used waterfowl migration corridor originates from major corridors down the Great Plains and Missouri-Mississippi River valleys eastward across the Great Lakes area to the Atlantic coast.

Three local and well-defined migration routes pass through Lucas and Ottawa Counties. One route follows the islands across Lake Erie from Catawba Island, OH, to Pelee Point, Ontario. This migration route is extensively utilized during spring and fall by passerines. The second local migration route is along the shoreline, crossing Maumee Bay near Cedar Point National Wildlife Refuge, and continuing along the west shore to the narrows south of Detroit, Michigan. Some of this shoreline route's frequent users in spring and fall are crows, geese, hawks, woodpeckers, swallows, and blackbirds. Snow buntings, lapland longspurs, horned larks, and water pipits are regular fall users of this route. A third migration route follows the Maumee River. This route is used by swallows in the spring and fall. Franklin's gulls and Forster's terns move into Lucas County from the west by this route as fall approaches.

The number of birds utilizing the various migration routes through southwestern Lake Erie and northwestern Ohio is difficult to estimate. Most of

the quantitative information on migration through Ohio concerns waterfowl. However, the direct use of this information tends to overestimate the waterfowl use of the southwestern Lake Erie area. Table 66 presents some estimates of waterfowl numbers migrating through West Harbor, Ottawa County, OH. Table 67 presents some 1974 data from observations of migrating waterfowl by Karl Bednarik of Crane Creek Wildlife Experiment Station.

Migration is a regular, annually induced movement, modified by local weather conditions. Despite the complex combination of factors which stimulate each species to migrate, the arrival and departure of birds year to year exhibits an impressive degree of regularity. In general, the migration movements of small passerines along Lake Erie are observed each spring in May and each fall from August to September. For waterfowl, spring migration movements along Lake Erie are observed earlier in spring from March to May and later in fall from September to November.

Two primarily local factors appear to determine the migratory use of Ohio by waterfowl. One major factor is spring weather conditions on the breeding grounds north and west of Ohio. Spring weather may delay nesting on breeding grounds or allow early nesting. More importantly for waterfowl, spring and winter precipitation are primarily responsible for water level conditions at breeding initiation and the duration of available water in prairie potholes and other wetlands areas. In general, when water levels are adequate and potential breeding and brooding grounds hold water until July, more waterfowl will be produced than in drier years. A high production of waterfowl results in more birds migrating south.

The second major factor is fall and early winter weather in Ohio. Generally, Lake Erie marshes freeze over in late November and early December. As these marshes freeze, waterfowl move south into the central and southern portions of the State. However, in years in which severe cold snaps occur throughout the State, as in 1977, when most of the State's waters froze over at the same time, most of the southern and central portions of the State received little or no use as birds overflew these areas.

The migratory use of Ohio by small passerines and by other migratory species can be expected to follow similar patterns given slight adjustments to their respective life histories.

The southwestern shore of Lake Erie is a wintering area for certain bird species. The number of wintering bird species fluctuates in number and in composition from year to year. In very cold winters, more winter visitors and less half-hardy species (summer residents and fall migrants); while in warmer winters, there are more half-hardy species and less winter visitors. Christmas bird counts indicate the presence of 56 species in 1975, 52 species in 1976, and 51 species in 1977.

Certain areas have particular attraction to overwintering birds. Open water areas which do not freeze attract fish and waterfowl. These areas may exist in association with falls and rapids along a stream or thermal outfalls into Lake Erie. Areas of food availability such as fall crop fields and unharvested soybeans near the study area will receive winter use by waterfowl.

Table 69 presents a modified version of the critical nesting and migration areas for Lucas and Ottawa Counties. "Critical areas" are those that serve as concentration points for nesting or migrating species. West Sister Island and North Bass Island are considered "critical areas" for the great blue heron, black-crowned night heron, and great egret. Darby Marsh is considered a "critical nesting area" for black tern in Scharf's original table. However, black tern is not a colonial nester. Since the quality of any given marsh may change from year to year, black terns would make use of any marsh or marshes which best satisfy their nesting preferences within a given year. Ballast Island and Starve Island (near South Bass Island) were cited as "critical nesting areas" for herring gulls and ring-billed gulls. Ottawa NWR, Magee Marsh, Ottawa Shooting Club Marsh, Winous Point Shooting Club Marsh, Green Island, and Cedar Point NWR were listed as "critical nesting areas" for the bald eagle.

In addition to these areas, Maumee Bay and the lower end of the Maumee River have been noted in literature as resting areas for many varieties of waterfowl and feeding areas for diving ducks, grebes, gulls, and terns.

f. Mammals - Forty-two species of mammals have ranges which fall within the study area. Table 70 lists mammals occurring in the study area and their habitat preferences. The species list includes one marsupial, five insectivores, nine bats, nine carnivores, sixteen rodents, one lagomorph, and one ungulate. All but two species, the Norway rat and house mouse, are endemic to North America. The species diversity of the islands is understandably low considering their isolation from the mainland and the small area available on any particular island. Only 13 species have been recorded as being permanent island residents, and these are all small mammals.

As with birds, the mammalian fauna changed with the alteration of habitat. Certain species, such as opossum, eastern mole, deer mouse, and cottontail, expanded their ranges as a result of clearing land and creation of an open type habitat. Other species such as the gray squirrel, a woodland species, have more restricted ranges than in the past. Man also has had an effect on certain mammal species through hunting, trapping, and various agricultural activities.

The muskrat is a furbearer which is trapped in many of the marshes along Lake Erie. From the 1939-1940 to 1950-1951 trapping seasons, approximately 96,900 muskrats were trapped on Magee Marsh. Trapping success at Magee Marsh has been lower in recent years due to water drawdown practices. The Ottawa NWR staff noted that in 1974 muskrat populations appeared to be decreasing as a result of selective trapping. The muskrat population estimate for the Ottawa NWR Complex in 1977 was 12,000 animals.

White-tailed deer populations along the Lake Erie shore appear to be low. The Ottawa NWR staff estimates the white-tailed deer population utilizing the refuge and neighboring areas to be approximately 30 individuals with approximately eight young produced each year.

Human Environment

1. Land Use - Figures B18 and B19 show the land us. as of 1975 for Lucas and Ottawa Counties, respectively. From these computer-generated plots and the tabulation of use by category shown below, it is seen that the predominant use is agriculture with about 44 percent and 69 percent of the lands in Lucas and Ottawa Counties, respectively in agriculture. With regards to the flood-and-erosion prone areas contiguous to Lake Erie, much of these lands are undeveloped wetlands with a significant portion of the remainder in agricultural use.

	Lucas County		Ottawa County	
Land Use	Acres	Percent of Total	Acres	Percent of Total
Urban	49,000	22	9,000	5
Utility	300	-	300	-
Recreation	14,000	6	3,000	2
Agriculture	98,000	44	118,000	69
Forested	26,000	12	9,000	5
Wetlands	4,000	2	11,000	6
Other	31,000	14	22,000	13
Totals	222,300	100	172,300	100

2. Demography - The population of Lucas and Ottawa Counties totaled 521,460 in 1970. Of this total, 94.1 percent of the population of Lucas County and 27 percent of the population of Ottawa County was considered urban. The major population center in the study area, Toledo, had over 384,000 inhabitants with a population density of 4,718 persons per square mile. Other urbanized areas along the shore include the cities of Oregon and Port Clinton with 16,563 (585 per square mile) and 7,202 (4,001 per square mile) persons, respectively. Population densities for Lucas and Ottawa Counties are 1,410 and 142 persons per square mile, respectively. Kelleys Island, which is located in Erie County, has a winter population of approximately 140. During the summer months, the population averages 2,000 to 3,000. Due to the tourist-related economy of the eastern portion of the study area, similar population fluctuations are experienced on the Bass Island and Catawba Island and Marblehead peninsulas. Table B7 indicates the population distribution of the townships and incorporated places which border the western Lake Erie shore.

Moderate population growth is anticipated for Lucas and Ottawa Counties. The population of Lucas County is expected to increase from 581,600 in 1985 to 600,100 in 2000 (Statistical Abstract of Ohio, 1969). At the same time, Ottawa County would increase from 50,200 to 63,900. Those areas expected to experience the greatest growth rates would be Toledo and surrounding areas and the resort areas to the east of Port Clinton.

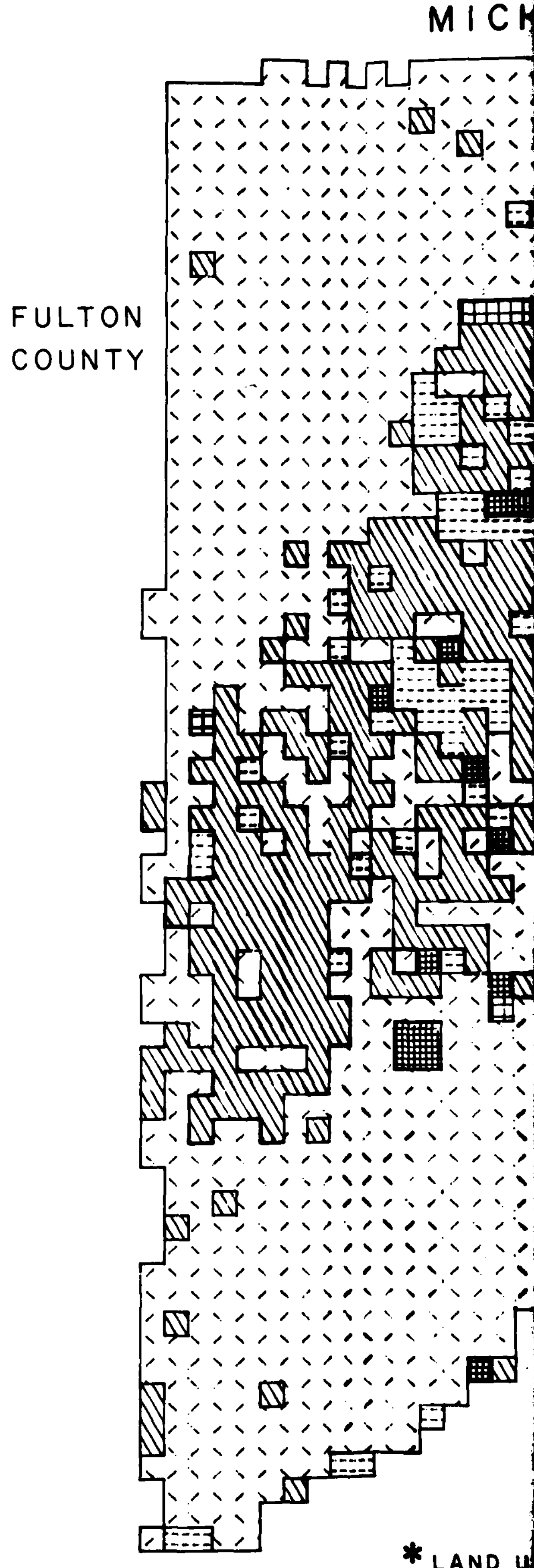
LUCAS COUNTY, OHIO

LAND USE *

U.S. ARMY ENGINEER DISTRICT,BUFFALO
WESTERN LAKE ERIE SHORE STUDY

APPROXIMATE SCALE 1:148,000

DATA BASE YEAR 1975



URBAN

UTILITY

RECREATIONAL

AGRICULTURAL

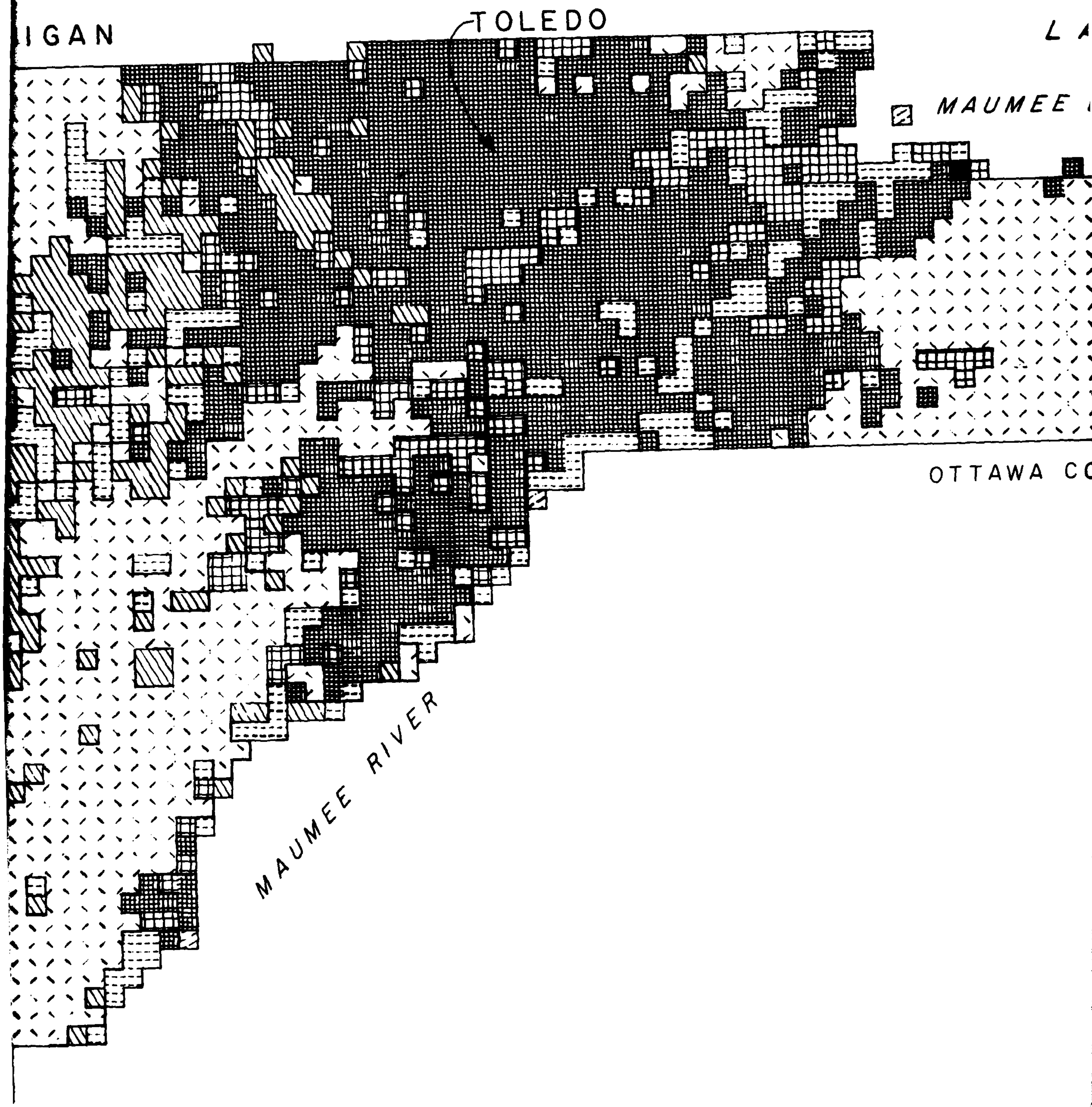
FORESTED

WETLANDS

OTHER LAND USE

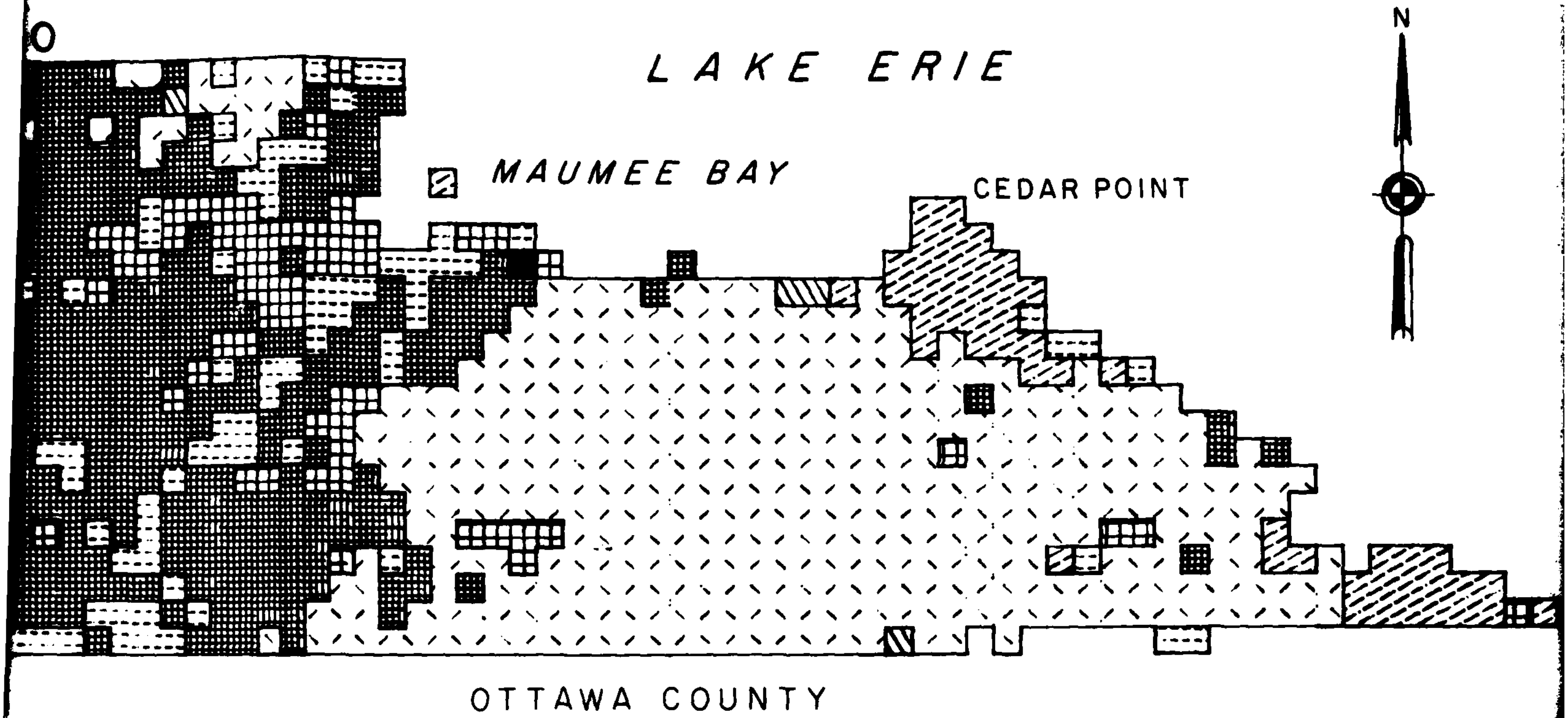
LUCAS COUNTY, OHIO LAND USE

GRID SHADE, SUNY/BUFFALO



USE MAPS DERIVED FROM THE LAKE ERIE WASTEWATER MANAGEMENT STUDY LAND RESOURCES INFORMA

2



MANAGEMENT STUDY LAND RESOURCES INFORMATION SYSTEM

FIGURE

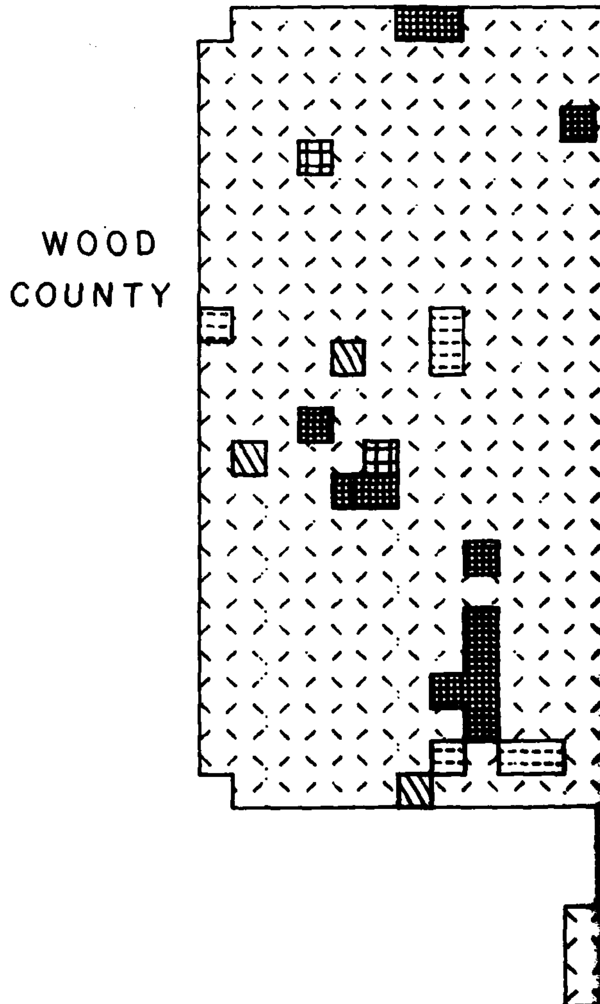
OTTAWA COUNTY, OHIO

LAND USE *

U.S. ARMY ENGINEER DISTRICT, BUFFALO
WESTERN LAKE ERIE SHORE STUDY

APPROXIMATE SCALE 1:125,000

DATA BASE YEAR 1975



URBAN

UTILITY

RECREATIONAL

AGRICULTURAL

FORESTED

WETLANDS

OTHER LAND USE

OTTAWA COUNTY, OHIO LAND USE

GRID SHADE. SUNY/BUFFALO

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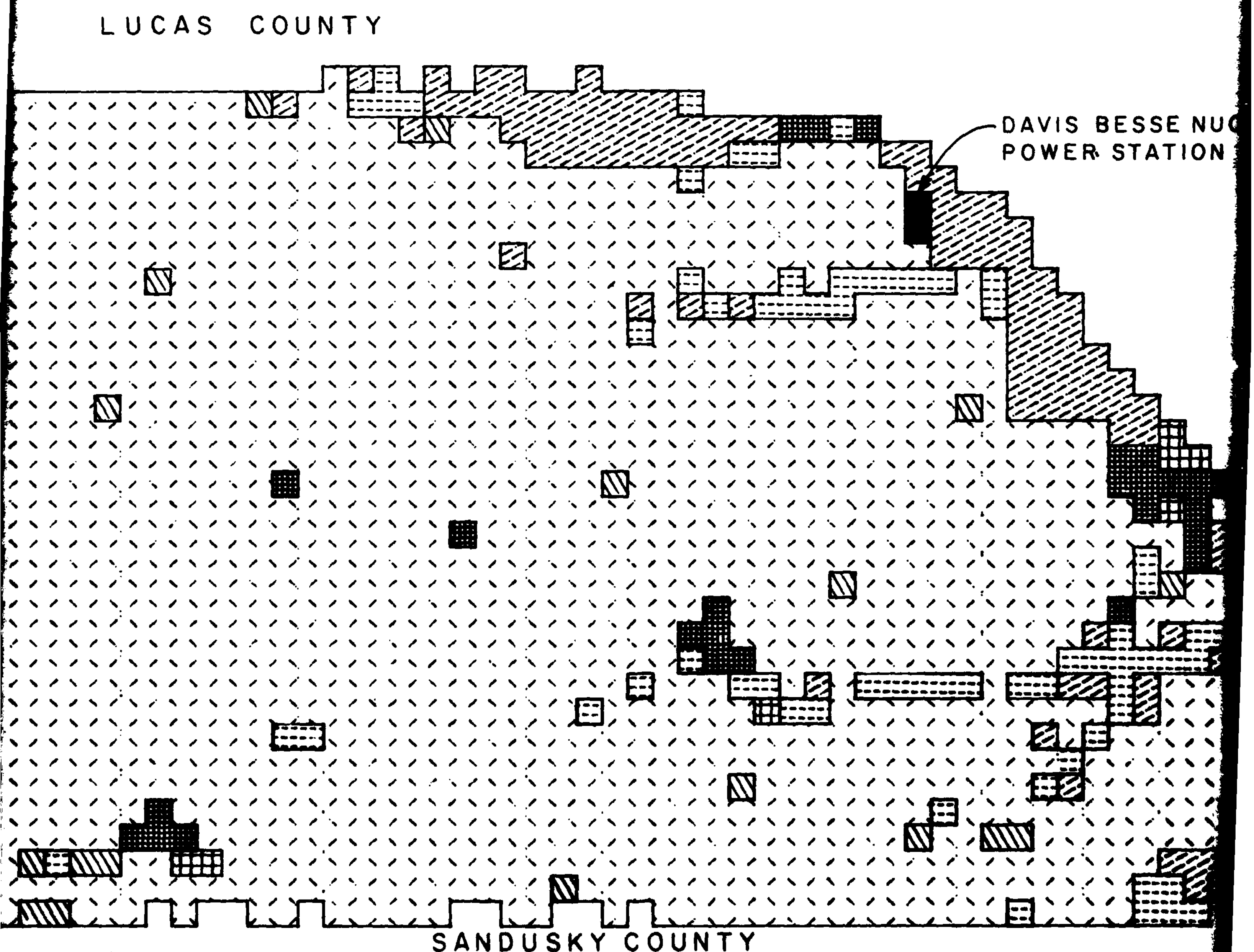
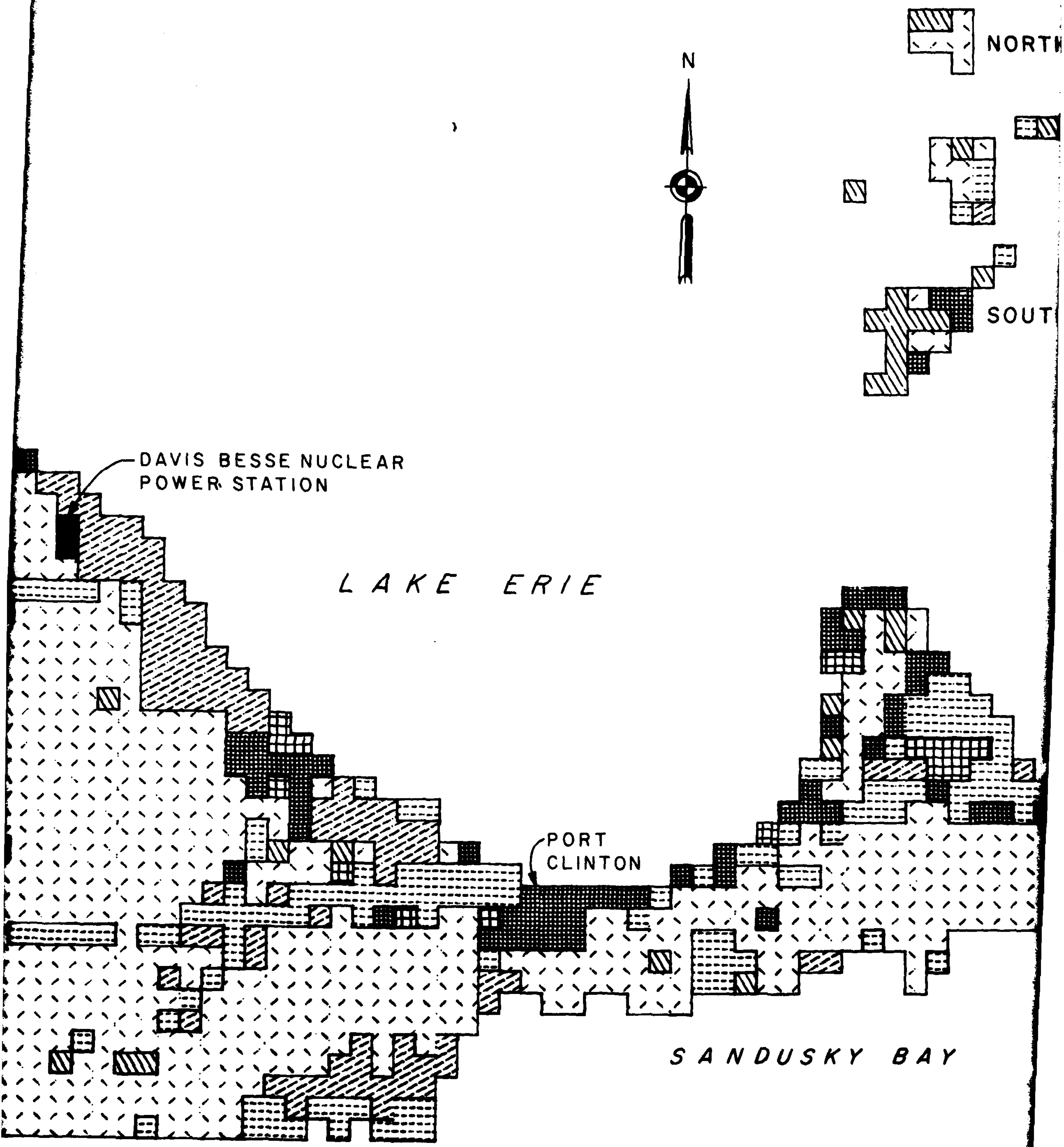
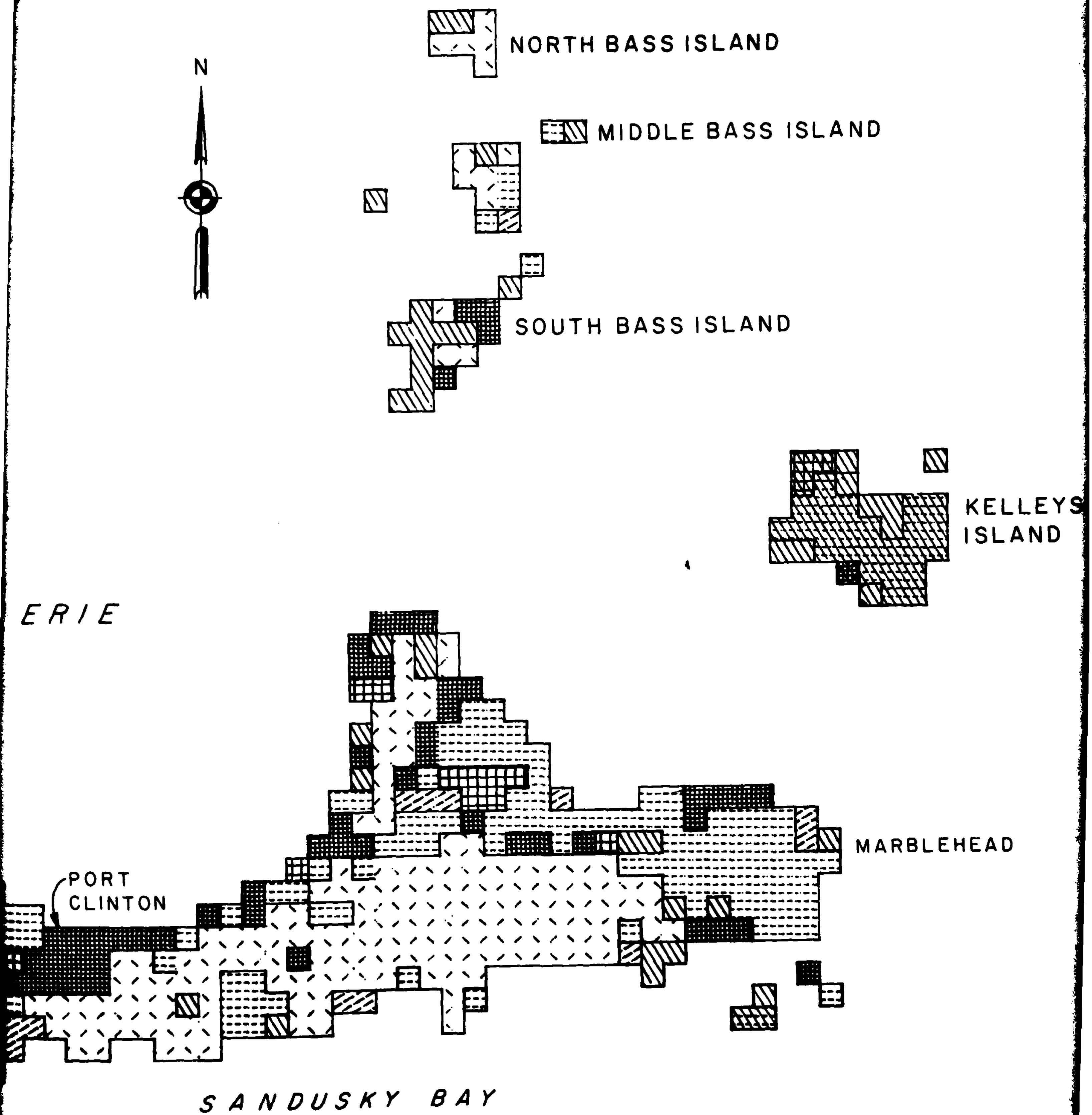


D USE MAPS DERIVED FROM THE LAKE ERIE WASTEWATER MANAGEMENT STUDY LAND RESOURCES IN



STUDY LAND RESOURCES INFORMATION SYSTEM

3


NORTH BASS ISLAND
N
MIDDLE BASS ISLAND
SOUTH BASS ISLAND
KELLEYS
ISLAND
ERIE
MARBLEHEAD
PORT
CLINTON
SANDUSKY BAY

EM

FIGURE

Table B7 - Population Distribution by Townships and Incorporated Communities, 1970-1995

	1970	1995	Percent Change 1970-1995
Townships			
Jerusalem	3,405	4,370*	28.3
Carroll	1,355	1,400	3.3
Erie	1,470	1,700	15.6
Bay	1,798	2,350	30.7
Portage	7,948	9,600	20.7
Catawba Island	2,882	5,100	77.0
Danbury	3,760	5,000	33.0
Put-in-Bay	507	700	38.1
Incorporated Communities			
Toledo	384,015	401,939	4.7
Oregon	16,563	-	-
Port Clinton	7,202	8,700	20.8
Marblehead	730	1,350	84.9
Put-in-Bay	140	200	42.9
Kelleys Island	140	-	-

* Year 2000

Source: Ottawa County Regional Development Plan, 1971
Jerusalem Township Land Use/Impact Plan, 1979

3. Housing and Structures - The nature of the study area, which ranges from urban areas such as Toledo and Port Clinton to broad agricultural areas, makes a summary assessment of the housing stock nearly impossible. Census information at the county and city level, presented in Table B8, reflect housing in a general nature. In 1970, over 172,000 housing units were encompassed by Lucas and Ottawa Counties. Of these, over 137,000 were located within the cities of Toledo, Oregon, and Port Clinton. An inventory carried out by the Ottawa Regional Planning Commission in 1971 determined the condition of housing by an exterior inspection. Of the 10,756 dwelling units surveyed, slightly less than 17 percent of the permanent housing was in need of some form of repair. Among those Ottawa County townships within the study area, Carroll Township housing was in the greatest need of repair (23 percent) and Catawba and Put-in-Bay were the least in need of repair (3 percent and 5 percent, respectively).

Table B8 - Housing Characteristics, 1970

	Year-Round Units								Occupied Units					
	Total	Change 1960-1970	Median Number of Rooms	In One-Unit Structures	In Structures Built in 1960 or Later	In Structures Built Prior to 1950	Vacancy Rate: Home-owner	Vacancy Rate: Rental	Total	Average Persons Per Unit	Owner-Occupied	Median Value Owner-Occupied, Single Family	Median Gross Rent, Renter-Occupied	Lacking Some or All Plumbing Facilities
		%		%	%	%					%	$ (1970)	$ (1970)	%
Lucas Co.	159,712	9.1	5.4	71.9	17.1	63.6	0.8	6.2	153,880	3.1	68.4	17,110	101	2.3
Ottawa Co.	13,002	-2.5	5.6	85.7	20.6	60.8	1.3	7.9	11,521	3.2	77.0	16,306	95	4.3
City of Toledo	130,303	23.3	5.3	68.5	13.9	68.6	0.8	6.2	125,375	3.1	65.5	16,209	98	2.1
City of Oregon	4,933	26.7	-	-	-	-	-	-	-	-	-	-	-	-
City of Port Clinton	2,452	4.4	-	-	-	-	-	-	-	-	-	-	-	-

Source: County and City Data Book 1972, U.S. Department of Commerce

4. Business and Industry - The Toledo metropolitan area is the dominant manufacturing center in the study area. Toledo's location on the Great Lakes, combined with its inland connections, established the city as a major industrial and transportation center. Approximately 200 large plants (more than 100 employees) are located within the 3-county Toledo SMSA. Today, Toledo is the third largest port on the Great Lakes and the center of industry and trade for northwestern Ohio. Toledo is among the nation's leading coal handling ports and is considered the automotive parts and glass capital of the nation. The largest petroleum refining center between Chicago and the eastern seaboard is located in Toledo. In addition, Toledo contributes approximately 24 percent to the U.S. shipment of nonlaboratory scales and balances. A secondary industrial center within the study area is the Erie Industrial Park located on State Route 2 north of LaCarpe Creek. This is a lakeshore area of Erie Township, Ottawa County, which was formerly a part of the U.S. military reservation of Camp Perry. The park encompasses approximately 20 firms of miscellaneous types with a total employment of 900 people. The largest firm is the Uniroyal Corporation, employing 300 people and manufacturing coated fabrics. Commercial stone quarries (limestone, dolomite, and gypsum) operate on Marblehead Peninsula, South Bass Island, and Kelleys Island.

Agriculture plays an important role in the economy of the area due to the high productivity of the land. In 1974, the market value of agricultural products sold per farm was $39,853 for Lucas County and $22,626 for Ottawa County. The value of products sold per farm for the State of Ohio was $24,551. Proximity to Lake Erie serves croplands by modifying temperatures and effectively delaying spring budding and prolonging fall growth. Major crops in the area are soybeans, wheat, corn, and other grains, although specialized crops, notably grapes, are important crops raised on the Catawba Island and Marblehead peninsulas, the Bass Islands, and Kelleys Island. Low elevations and generally impervious subsoils are limitations to agriculture in the area which make cultivation difficult unless adequate drainage is provided. With adequate drainage, the soils prove to be highly productive. In general, agricultural areas are on the decline throughout Ohio due mainly to incremental conversion along rural roadways to urban users, usually residential.

Commercial activity as a general rule is concentrated within large population centers such as Toledo, Oregon, and Port Clinton. Dispersed locations of commercial establishments also occurs along the major roads and highways in the area. A noticeable increase in commercial development in the eastern townships of Ottawa County (Catawba, Danbury, and Put-in-Bay) and Kelleys Island in Erie County is primarily associated with recreation and resort oriented activities. The natural fishing areas of western Lake Erie have encouraged the development of several commercial marinas and boat launch facilities which are typically located along and at the mouths of the major streams in the area and the natural harbors of the lake islands.

5. Employment and Income - Comparative employment statistics for Lucas and Ottawa Counties and the major population centers within the study area are presented in Table B9. In general, the figures presented typify a diversified economy. The Great Lakes Basin Framework Study analysis for planning

Table B9 - Employment Statistics, 1970

Occupation	Lucas Co.	%	Ottawa Co.	%	Toledo, OH SMSA	%	Oregon	%	Port Clinton	%
Professional, Technical, and Kindred Workers	26,774	14.2	1,407	10.6	27,059	14.5	777	11.6	366	13.6
Managers and Administrators, Except Farm	14,469	7.7	1,104	8.3	14,565	7.8	610	9.1	207	7.7
Sales Workers	13,817	7.3	795	6.0	13,945	7.5	466	6.9	178	6.6
Clerical and Kindred Workers	34,183	18.1	1,929	14.5	34,202	18.3	1,071	15.9	446	16.5
Craftsmen, Foremen, and Kindred Workers	27,866	14.8	2,722	20.5	27,017	14.5	1,198	17.8	519	19.2
Operatives, Except Transport	29,240	15.5	2,292	17.3	28,674	15.3	1,088	16.2	162	6.0
Transport Equipment Operatives	7,852	4.2	591	4.5	7,756	4.1	319	4.8	99	3.7
Laborers, Except Farm	9,013	4.8	569	4.3	8,859	4.7	324	4.8	129	4.8
Farmers and Farm Managers	498	0.3	220	1.7	275	0.1	23	0.3	-	-
Farm Laborers and Farm Foremen	457	0.2	164	1.2	325	0.2	41	0.6	6	0.2
Service Workers, Except Private Household	22,713	12.0	1,392	10.5	22,333	11.9	791	11.8	307	11.4
Private Household Workers	1,933	1.0	87	0.7	1,905	1.0	35	0.5	11	0.4
Total	188,815		13,272		186,915		6,713		2,698	
Unemployed		4.1		4.8		4.3		-		-

Source: 1970 Census of Population, U.S. Department of Commerce

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subarea 4.2, which includes the study area, reported that employment is expected to increase slightly more rapidly than population, and the rate of growth in total income is expected to be slightly above the Great Lakes Basin and national rates of 4 percent.

Table B10 exhibits comparative income statistics for counties and cities bordering the western shore of Lake Erie. Median income for Lucas County ($10,803) exceeds that of the State of Ohio ($10,300) while that of Ottawa County ($9,760) falls below. Counties associated with urban areas generally enjoy higher income levels than rural counties. Lucas County, which is included within the Toledo Standard Metropolitan Statistical Area (SMSA), is economically and socially related to the central city of Toledo. The variability of income levels between Lucas County, with its urban influence, and the more rural Ottawa County is related more to the employment structure and the greater proportion of higher paying positions (e.g., professional, technical, etc.) rather than the actual gross income levels.

Table B10 - Income

Area	Families, 1970	Income in 1969												
		Families with Income								Families Below -		Persons Below Low Income Level		
	Total	Less Than $3,000	$3,000-4,999	$5,000-6,999	$7,000-9,999	$10,000-14,999	$15,000-24,999	$25,000 or More	Median Family Income	Low Income Level	125% of Low Income Level	Number	65 Years and Over	Per Capita Money Income
		%	%	%	%	%	%	%	$	%	%		%	$
Ohio	2,691,130	7.9	7.6	10.0	22.1	30.8	17.4	4.2	10,309	7.6	10.9	1,042,082	23.3	3,199
Lucas Co.	122,263	7.1	7.4	8.5	20.9	32.0	19.4	4.7	10,803	7.0	9.7	47,008	23.5	3,408
Ottawa Co.	9,594	8.5	8.4	10.9	24.0	31.1	15.1	2.0	9,760	7.1	10.8	3,323	31.1	2,847
Toledo	97,064	7.8	7.9	9.2	21.7	31.7	18.3	3.4	10,452	5.7	8.3	2,902	25.3	3,252
Oregon	4,240	4.7	5.5	5.8	19.2	36.6	24.4	3.6	11,746	4.1	5.8	864	17.9	3,618
Port Clinton	1,822	9.7	6.5	11.0	25.8	31.3	13.7	2.0	9,669	8.5	-	-	-	2,933

Source: County and City Data Book 1972, U.S. Department of Commerce

6. Transportation - Ohio State Highway 2, a main connecting route between Toledo and Sandusky, is the major thoroughfare in the area. The Ohio Turnpike (Interstate 80/90) is about 13 miles south with interchanges at State Route 53, which travels north to Port Clinton, and at Interstate 280, which travels north to Toledo and Detroit. Access roads in the area are generally based on a one-mile square grid of county highways. The basic grid network of roads is interrupted by significant bodies of water such as the Toussaint and Portage Rivers and the marsh areas along Lake Erie. Coast-to-coast rail passenger service, provided by AMTRAK, runs between Toledo and Sandusky via Port Clinton. Freight trains in the area include CONRAIL, the Detroit-Toledo Shoreline Railroad, the Baltimore and Ohio Railroad, the Norfolk and Western Railraod, and the Toledo Terminal Railroad. The major airport in the area is the Toledo Express Airport which provides jet service to and from many major cities. Other airfields in the area include Port Clinton and Kelleys Island Municipal Airports and local facilities on each of the Bass Islands. Seasonal ferry service is provided from Port Clinton and Catawba Island to the Bass Islands and from Marblehead to Kelleys Island. Toledo Harbor is Federally-maintained with a 28-foot deep channel that extends about 18 miles from the mouth of the Maumee River to deep water in Lake Erie. The Maumee Bay Channel is connected by a 1,200-foot wide sailing course to the East Outer Channel of the Detroit River. Port Clinton Harbor is a 5,000-foot long Federal navigation channel that is dredged to a depth of 10 feet on an "as needed" basis. East of the study area is Sandusky Harbor which is Federally-maintained at depths of 21 to 25 feet. The Toledo metropolitan area is serviced by TARTA, the Toledo Area Regional Transit Authority, which provides bus service to the residents.

7. Utilities - Electrical power is supplied to the study area by the Toledo Edison Company. As a member of the Central Area Power Coordination Group, Toledo Edison operates the Davis-Besse Nuclear Power Station on Locust Point. The station is located about 21 miles southeast of Toledo and occupies a 954-acre site, with a 7,250-foot frontage along Lake Erie. The station operates at 2,772 megawatts thermal (MWt) with a net electrical output of about 906 MWe. A 21-mile long transmission line route with a 150-foot right-of-way extends northwesterly from the station to the Bay Shore Substation on Maumee Bay. Other publicly franchised utility companies provide additional utility service to the study area. The area is extensively served by electrical, telephone, and gas company service. The lake islands, however, are not served with piped natural gas service. Water intakes are located offshore of Cooley Creek (2 - Toledo and Oregon municipal), Port Clinton (2), Lakeside, Marblehead, Put-in-Bay, Kelleys Island, Davis-Besse, and Erie Industrial Park. Reno Beach-Howard Farms in Lucas County and the Catawba area of Ottawa County depend upon wells for their water supply.

8. Recreational Resources - The southwestern Lake Erie area provides the public with numerous recreational opportunities throughout the year. Tourists and vacationers are attracted by the lake and the significant Lake Erie islands. The major recreation period is from Memorial Day in May to Labor Day in September. Peak use occurs in the months of July and August. In summer, various private, municipal, State, and Federal areas offer fishing, camping, hiking, picnicking, power-boating, sailing, sightseeing, nature study, sunbathing, and swimming. In spring, fishing, sightseeing, and

nature study become major activities. In autumn, hunting also becomes predominant. In winter, ice fishing, ice skating, cross country skiing, sledding, and snowmobiling are available.

Recreational boating is a popular and significant use of the western basin. In 1972, approximately 27 percent (60,500 boats) of the 222,000 boats registered in Ohio used Lake Erie as a principal water recreation location. According to the Midwest Research Institute's Boating Facilities Inventory, 1979, the Lake Erie shore from Toledo to Marblehead has available 28,012 wet berths or slips and 8,789 dry storage spaces for recreational craft. West Harbor, located along the Lake Erie side of Marblehead Peninsula with about 2,600 vessels berthed in the harbor, has the largest concentration of recreational boating on Lake Erie. Recreational fishing is also a significant activity in southwest Lake Erie, the Bass Islands, and the major rivers and streams. Of the nearly 1,000,000 licensed Ohio anglers, 32 percent indicated that they fish in Lake Erie. Approximately 55 percent of the Lake Erie angler-hours are from shore and 45 percent from boats. Boat fishing in the Western Basin is concentrated between Locust Point and Cedar Point at the mouth of Sandusky Bay, especially near Catawba-Marblehead. The Gem Beach Channel (West Harbor) on Catawba Island is the most heavily used departure site for recreational fishing boats.

Lake Erie provides year-round angling as various fishes become available at different seasons. Yellow perch are the mainstay of the winter ice fishery. River spawning migrations provide angling for walleye in March and April, and white bass in May and June. The summer lake fishery for freshwater drum, channel catfish, and smallmouth bass occurs from May through July, with angling for walleye and white bass best in July and August. The yellow perch lake fishery peaks in September and October. From 1975 to 1977, fishing for walleye has increased, dividing the summer into an early summer walleye season and a late summer perch season. In 1978, sport anglers harvested 46 percent (7.6 million pounds) of the four major species (perch, white bass, drum, channel catfish) taken by both commercial and sport fishermen.

Hunting is another significant recreational activity in the study area. About 63 percent of the Statewide hunting pressure and 72 percent of the waterfowl harvest occur in the northern part of Ohio. About 22 percent of the total Statewide waterfowl harvest occurs within the Lake Erie marsh areas of Lucas, Ottawa, Sandusky, and Erie counties, excluding the high quality private duck clubs in the area. Mallards, black ducks, wood ducks, and blue-wing teal make up approximately 70 percent of Ohio's annual harvest of more than 100,000 ducks. Mallards and black ducks are late migrants into Ohio and make up over half of the waterfowl reported during hunter bag checks conducted in the Lake Erie marsh areas. Wood ducks and blue-wing teals are early migrants and are less important to hunters along Lake Erie. In addition to waterfowl, Kelleys Island offers some of the best pheasant hunting in the State. Game and fur mammals offer additional hunting and trapping opportunities. Species found in the southwest Lake Erie area include muskrat, mink, raccoon, skunk, oppossum, fox, woodchuck, cottontail rabbit, fox squirrels, and white-tailed deer. Trapping is particularly important in the Lake Erie marshes with Ohio's high muskrat harvest due principally to trapping along Lake Erie. Muskrat trapping in the State- and Federally-

managed marshes and in some of the private duck clubs are controlled and regulated activities. Selection as to who is permitted to hunt or trap on public lands is generally made by lottery. Hunting in duck clubs is restricted to members. Landowners in areas neighboring the marshes may lease their lands to hunters.

A significant portion of Lake Erie shoreline within the study area is owned and administered by various Government agencies. The Ohio Department of Natural Resources, Division of Wildlife, has established several wildlife areas in the coastal area, namely Metzger Marsh (558 acres), Magee Marsh (1,831 acres), Little Portage (357 acres), and Toussaint (236 acres) Wildlife Areas. Metzger and Magee Marshes are managed primarily for waterfowl, but also provide public hunting, fishing, and nature study opportunities similar to those offered at the Little Portage and Toussaint Wildlife Areas. The Crane Creek Wildlife Experiment Station, located within Magee Marsh, is responsible for Statewide waterfowl research and management, marsh management, wetlands habitat development, and studies involving furbearing animals.

The U.S. Department of Interior, Fish and Wildlife Service, also administers several wildlife areas along Lake Erie. The Ottawa National Wildlife Refuge, which encompasses five units in the Western Basin, is the only national wildlife refuge in Ohio. These units are managed primarily for waterfowl and allow special public use for hunting and nature study. The Cedar Point unit is a 2,300-acre marsh located at the eastern end of Maumee Bay and is recognized as having the best duck hunting in the State. The Ottawa Division consists of 2,555 acres which adjoin the Magee Marsh State Wildlife Area. The Navarre Division, part of which is located on the Davis-Besse Nuclear Power Station site, occupies 591 acres. The Darby Division is 520 acres of special public use land leased by the Ottawa National Refuge from Toledo Edison and Cleveland Electric. This unit is located along Lake Erie north of the Portage River.

Several State parks administered by the Ohio Department of Natural Resources (ODNR), Division of Parks and Recreation, are located within the study area. Maumee Bay State Park (1,241 acres) occupies approximately 2 miles of Lake Erie shoreline. Present park activity is limited to recreational day use; however, ODNR has begun the construction of 250 campsites scheduled for opening in the spring of 1981. Future development planned for the park includes picnicking areas, a recreational beach, nature trails and interpretive center, a lodge and cabins, and an 18-hole golf course. Projected annual attendance for the year 1984 is one million visitors. Crane Creek State Park (72 acres) is located approximately 14 miles to the southeast. Major activities at the park include fishing, swimming, hiking, and picnicking. A new nature interpretive center and waterfowl hunting museum are open throughout the year. Catawba Island State Park (10 acres) occupies a small site on the peninsula along Lake Erie and serves primarily as a boat launch facility and picnicking area. East Harbor State Park (1,613 acres), located west of Marblehead, receives over 1.5 million visitors annually. The park has 600 camp sites, a boat launch and marina, and a long sand beach, extending for 2-1/2 miles, which is considered one of the finest along Lake Erie. South Bass Island State Park (32 acres) can be reached only by ferry or plane from Lakeside or Sandusky, OH. The park is situated on limestone

cliffs with excellent exposure on a rugged shoreline. Major activities at the park include boating, fishing, camping, swimming, and picnicking. Kelleys Island State Park (601 acres) is also located in Lake Erie about 10 miles from the mainland. The park offers boating, fishing, camping, swimming, picnicking, and natural scenery. Much of the park is covered by abandoned limestone quarries which are now returning to natural vegetation. Much of the area is available for hiking, exploring, and collecting fossils typical to the Columbus limestone. In addition, the park has the only swimming beach on the island.

Associated with population and recreation centers such as Toledo, Port Clinton, and Put-in-Bay are several municipal parks. These are generally small, high density recreation areas which are oriented towards day use by local residents. Local interests have constructed numerous marina facilities along the Lake Erie shore, particularly on Cooley Creek, Wards Canal, Turtle Creek, Toussaint River, Portage River, and the many embayments on Catawba Island, Marblehead, and the Lake Erie islands. In addition, several large commercial tourist attractions, including Mystery Hill, Prehistoric Forest, and African Safari have been developed on Marblehead Peninsula. Perry's Monument, administered by the National Park Service, commemorates Commodore Perry's victory in Lake Erie during the War of 1812 and is a major tourist attraction of South Bass Island. Naturally occurring geologic formations and prehistoric remains offer unique scenic opportunities for residents and tourists. Approximately 28 well-known caves exist on South Bass Island. Crystal Cave, consisting of celestite (strontium sulfate) crystals, is recognized as one of the world's largest geodes. The interior of the cave is covered with a mass of the prismatic mineral. The deposit is reported to be the biggest in the U.S. and contains the largest crystals, some measuring 18 inches in length. Glacial Grooves State Memorial, located on Kelleys Island, is included in the National Register of Natural Landmarks. The large grooves measure up to 12 feet in depth and 400 feet in length. They represent a relatively rapid moving mass of ice imbedded with very hard igneous or metamorphic boulders which scraped over the softer Columbus limestone layers to form the grooves. Inscription Rock, listed in the National Register of Historic Places, is a large limestone rock on Kelleys Island which has been inscribed with stylized human figures, pipes, and amorphous designs. The rock is surrounded by a walkway and is covered by a pavillion-type roof.

9. Cultural Resources - On 2 December 1980, coordination with the Heritage Conservation and Recreation Service, State Historic Preservation Office, and Regional Archeological Preservation Office was initiated. These agencies were provided with a map outlining the study area and were requested to provide any information on known cultural resources sites located in the study area. Only one letter of response has been received, from the Ohio State Historic Preservation Office. This letter indicated the information requested was available from the Regional Historic Preservation Office located in Toledo. In conversations with the Toledo office, they indicated that the information would be compiled and forwarded to the Buffalo District by mid 1981. At that time, the information along with a list of sites within the project area which are listed in the National Register of Historic Places, will be summarized in an appendix to the main report. A reconnaissance level cultural resources survey is anticipated to be completed by the end of the next stage of project planning.

Appendix I provides a composite list of references used to define the economic, social, and environmental characteristics of the study area.

FUTURE CONDITIONS

The purpose of this topic is to present a look at future conditions and to assess the direction of future development in the study area that encompasses the 60-mile reach of Lake Erie shoreline in Lucas and Ottawa Counties, Ohio. These future conditions serve to define the basis upon which impacts of development plans can be measured. This is commonly referred to as the "without project" conditions. Future conditions also serve to identify possible problems or needs which may not be apparent when analyzing existing conditions.

As the study progresses through Stages 2 and 3, alternative future conditions will be projected. From this range of alternative futures, the one which best reflects the constraints imposed by the economic, social, environmental, institutional, and political systems will serve as the "most probable future" for describing the "without project" condition.

For Stage 1, the identification of alternative futures has been limited to that available in existing literature. The following discussions provide a very preliminary identification of the "most probable future" conditions in the study area.

The study area is located entirely within the Toledo, Ohio-Michigan SMSA which includes Lucas, Ottawa, Wood and Fulton Counties, Ohio and Monroe County, Michigan. Based on OBERS projections, the population for this SMSA will increase from approximately 794,000 persons in 1980 to about 1.5 million in 2030, for an increase of about 87 percent during the 50-year planning period. If this estimate does materialize, the resulting development within the SMSA will produce even greater pressures for additional residential, commercial, industrial, and recreational land uses in the coastal areas of Lucas and Ottawa Counties.

Per capita income for the Toledo area is expected to increase. It is expected that the greatest increase will occur in Lucas County, Ohio and Monroe County, Michigan because of their proximity to the city of Toledo where the primary industrial and commercial bases are located.

Thus, the future is characterized by change including increased population, rapid urbanization, increased productivity and affluence, and technological advances. The resulting increase in urbanization, which is land use intensive, will undoubtedly be at the expense of agriculture and undeveloped lands. However, it is expected that the rate of loss of lands in the coastal zone will be disproportionately less because of constraints such as flooding and shoreline erosion, public ownership of considerable coastal lands, the high cost of reclaiming marsh and wetlands, and contemplated long-range institutional programs such as the Ohio Coastal Zone Management Program and creation of agricultural districts and designation of prime and important farmlands.

As would be expected, the coastal zone region is an ideal location for a variety of recreational activities. Areas designated as open space which should remain in this state are those not suitable for development. Much of the coastal zone in the study area - being wetlands, marshes, flood hazard areas, areas subject to ponding, and areas subject to critical erosion - is in this category, and should be preserved or developed in nonintensive use compatible with the physical environment. Many types of recreation developments and wildlife management developments meet this requirement with proper planning, design, and construction. Prime examples in the study area are the Cedar Point National Wildlife Refuge, Metzger Marsh, Magee Marsh, Crane Creek State Park and East Harbor State Park.

Increased population and leisure time and the existence of highly productive fishing areas, particularly in the Island Region at the eastern end of the study area, will generate a greater demand for additional marina facilities to serve the recreational navigation need. An uncompleted boating demand study being prepared for the Buffalo District by Midwest Research Institute indicates a projected need for an additional 2,600 slips in the westerly reach of Lake Erie by the year 2035. Recent requests for Federally-constructed small-boat harbors on Kelley's Island and at the mouth of the Toussaint and Portage Rivers, and initiation of construction of the West Harbor Small-Boat Harbor project in the spring of 1981 reinforce this projected need.

The Ohio Department of Natural Resources is presently developing a multi-use recreation complex at Maumee Bay State Park which is about 5 miles east of Toledo. This 1,241 acre park will include facilities for camping, picnicking, golfing, a lodge, cabins, a nature area, and a swimming beach, contingent upon construction of a Federal shore protection project at the project.

It is expected that the wildlife resources of the study and contiguous areas will be subjected to increased adverse impacts in the future, primarily because of land use intensification. Population increases will cause losses of wildlife habitat through the various activities that demand road and utility construction, housing developments, industrial parks, recreation areas, etc.

Recent studies have shown that the water quality of Lake Erie has improved from its degraded state of the recent past. The Federal Government's mandate to clean up the nation's waters is expected to provide the impetus and necessary safeguards to protect and enhance water quality. Programs such as standards for point source effluents, bans on the use of detergents, confinement of polluted dredged materials, and controls on fill and dredge activities along shorelines and tributary streams should have a positive effect on the water quality of Lake Erie. Research programs such as the Buffalo District's Lake Erie Wastewater Management Study will provide a greater understanding of the Lake Erie water quality problem and associated causes, and provide recommendations for implementing viable best management practices for reducing contributions from nonpoint sources of pollution.

PROBLEMS, NEEDS, AND OPPORTUNITIES

The purpose of this discussion is to identify the full range of problems, needs, and opportunities associated with the water and related resources of the 60-mile reach of Lake Erie shoreline in Lucas and Ottawa County, OH. These factors have been identified by analyzing existing literature, and more importantly, evaluating the concerns expressed by the public. In this evaluation, Buffalo District conducted field reconnissances and in some locations obtained field surveys to quantify the damages sustained and problem significance.

The types and locations of specific problem areas within the study reach were briefly discussed in a previous subsection and their general locations shown on Figure B8. Each of these locations is discussed below under the general topics of shoreline erosion, flooding, recreation (excluding recreational boating), recreational boating, commercial navigation, agriculture, fish and wildlife, water quality, unplanned development, dissemination of information, and aesthetics.

Shoreline Erosion

Erosion is a natural process and its severity is a function of several factors such as water depth and level; wind direction, strength and duration; shoreline orientation and fetch distance across open water; and the composition of native shoreline material. Although shoreline erosion is a continuous process, it usually manifests itself by storm-induced wave action, and for highly susceptible locations is particularly devastating when storms occur concurrently with periods of high lake levels. By itself, erosion is not a problem, but when associated with shoreline development, a conflict between man and nature arises. The severity of the problem is a function of the rate of erosion and the economic value attached to the resulting loss.

Cognizant of the study's primary purpose, which is to address erosion and flooding, the emphasis was placed on identifying the shoreline where erosion and flooding are problems. Also, recognizing that existing legislation limits, for the most part, Federal participation in erosion control problems to publicly owned lands, the primary emphasis has been directed toward such lands although the privately owned shoreline that is susceptible to erosion has been identified.

The existing literature was used almost exclusively in identifying the general nature and extent of the erosion problem in the study area. The primary sources of information were published Corps reports including the Great Lakes Region Inventory Report, National Shoreline Study (August 1971) and a 1978 report entitled Lake Erie Shore Erosion and Flooding, Lucas County, Ohio, by D. Joe Benson of the Ohio Department of Natural Resources. From these sources, a composite of the erosion situation in the study area was established as shown on Figures B20.1 through B20.3 in the envelope at the back of this report.

The shoreline in the study area is generally highly erodable except at the eastern end where rock outcroppings exist. For this reason, the shoreline is

dotted with various types of protective works, both public and private. Photographs presented earlier in this section depict some of these structures. In Lucas County, for example, approximately / miles (or 30 percent) of the shoreline has some type of artificial protection consisting primarily of seawalls and groins (Benson, 1978). About 80 percent of these structures are privately owned, and 65 percent are judged to be in good or fair condition. Of the more than 200 structures along the Lucas County shoreline, many were constructed subsequent to the most recent high water period beginning in 1972, and they typically protect between 50 and 200 feet of shoreline. The largest shore structures in Lucas County are located at Point Place (about 9,000 feet of dike), Lakefront Dock, and Railroad Terminal in Toledo Harbor (20,000 feet of riprapped dike), and Reno Beach-Howard Farms (15,500 feet of armored dike). Similar types and extent of protective works exist in Ottawa County concentrated at Locust Point-Long Beach-Sand Beach, Camp Perry, the Ottawa Wildlife Refuge, in the Port Clinton area, and at East Harbor State Park.

Although erosion is critical along most of the unprotected shoreline, a large portion of these problem areas are either in private ownership and not eligible for Federal participation for implementation, or are publicly owned lands where no interest in obtaining shoreline protection has been shown by the affected agency. Specific locations where a need for shore protection works has been expressed are: Maumee Bay State Park, East Harbor State Park, Middle Bass Island, and Put-in-Bay on South Bass Island. The Maumee Bay and East Harbor State Parks problem areas are briefly discussed below. The areas of concern on Middle and South Bass Islands are very limited in extent and can be addressed under the Continuing Authority (Small Projects) Program, so they will not be discussed further in this report.

1. Maumee Bay State Park - This partially-developed, 1,241-acre State Park is located in Lucas County, OH, approximately 5 miles east of Toledo. It has 11,000 feet of shoreline along the south shore of Maumee Bay, and under the State's contemplated master plan will provide opportunities for camping, swimming, picnicking, hiking, fishing, and golfing. The development began in 1979, and to date (winter 1980) a park office has been constructed and construction of the campsites and internal roadways were nearly completed.

Soils in this area are typically clays and silts with minor amounts of sand and gravel, and are highly erodible. Except for a small section in mid-reach where rubble-type protection has been placed, erosion of the shoreline is critical with a long-term average recession of nearly 12 feet per year. It is projected that an additional 140 acres of shoreline will be lost over the next 50 years unless the shoreline is protected. The Ohio Department of Natural Resources (ODNR) will not develop such park facilities as the lodge, cabins, and golf course and only construct a limited amount of picnicking area without shoreline protection along the entire 11,000 feet of shoreline. ODNR has requested Corps assistance in constructing the shoreline protection project including incorporation of a recreational beach. As will be discussed further in Section C, the Buffalo District is presently conducting an Interim Feasibility Study for the park under this study authority.

2. East Harbor State Park - This park is located in Danbury Township, Ottawa County, OH, approximately 45 miles east of Toledo. It consists of about 1,613 acres, including 848 acres of water on West, Middle, and East Harbors. It contains 570 Class "A" campsites, several boat-launching ramps, a marina, and about 2 miles of sand beach. The long-term recession rate in this area is about 3.4 feet per year, and approximately 150 feet of beach width has been lost at the park since the most recent high water period that began in 1972. The Ohio Department of Natural Resources wishes to restore the 10,900 feet of eroded swimming beach fronting the park. Beach attendance has dropped from about 800,000 users in 1967 to about 240,000 in 1977, and park officials attribute this drop to the erosion of the beach. The results of the recently-completed Section 103 Reconnaissance Report for East Harbor State Park are discussed in Section C of this report, and the rationale for continued study of this beach erosion problem under the Western Lake Erie Shore Study is also presented in Section C.

Flooding

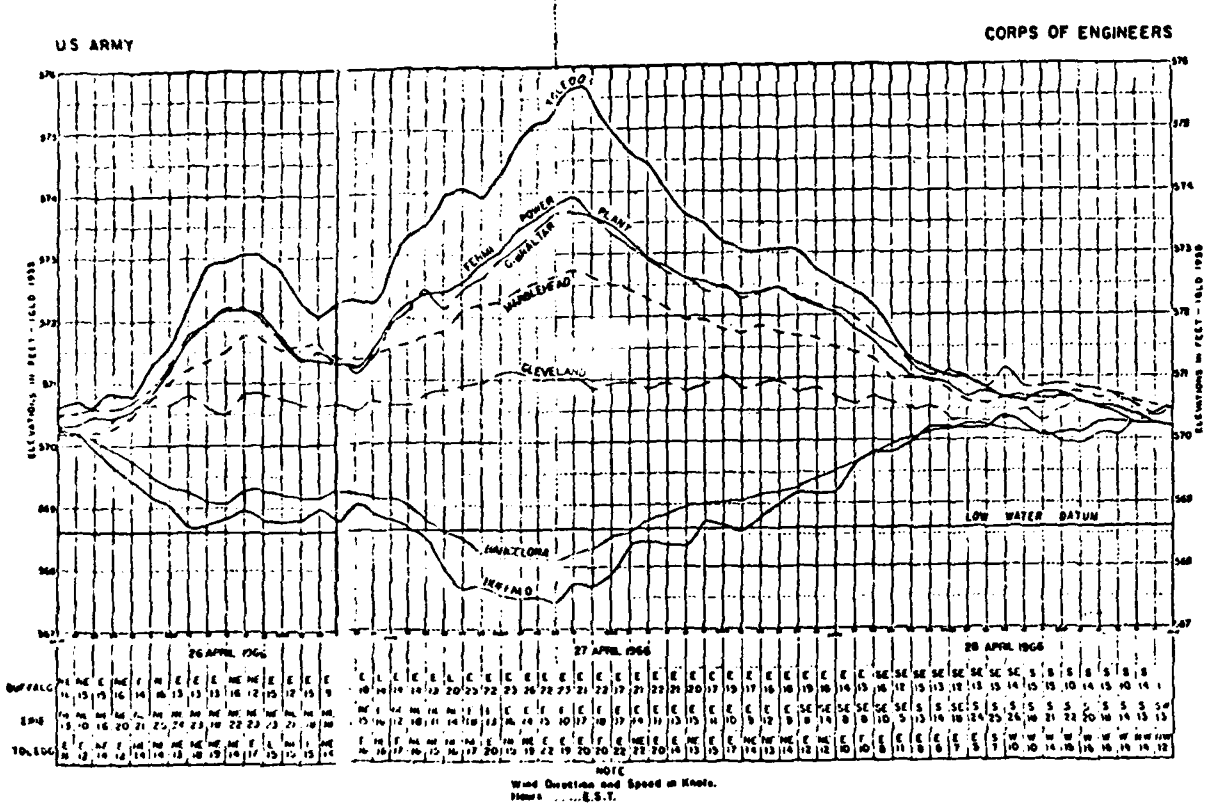
Flood damages along the Lake Erie shoreline can generally be divided into two categories:

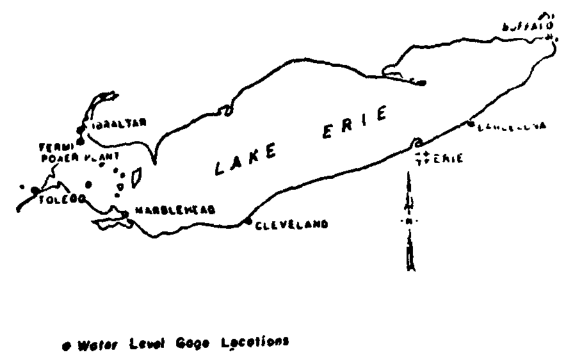
a. Those resulting from inundation due to the level of the lake; and

b. Those resulting from inundation and impact damage from waves.

Because much of the shoreline in the study area is low-lying, being generally less than 5 feet above the average lake level of 570.6 IGLD, frequent flooding occurs. Since the contigious lake plain provides very little topographic relief, flooding from the lake extends several miles inland as is shown on the Flooded Area Maps of Figures B21.1 through B21.3 in the envelope on the back cover of this report. From these maps, over 90 percent of the shoreline is floodprone, and the total floodprone area due to flooding from Lake Erie is approximately 40,000 acres, with 17,000 acres being in Lucas County and 23,000 acres in Ottawa County.

Flooding along the western shore of Lake Erie is most extensive and frequent during periods of high lake levels in combination with short-term rises in lake level caused by high winds from the northeast. The plot of Lake Erie levels at seven shoreline locations for the 27 April 1966 flood event, shown on Figure B22, depicts the effect of the short-term rise. The estimated total flood damages in the 60-mile study reach were estimated at $925,000 for the April 1966 flood when 1,318 residential units and 24 commercial units were flooded. Other floods produced by large short-term rises in Lake Erie levels occurred on 14 November 1972, 9 April 1973, 8 April 1974, and 14 April 1980. For comparative purposes, Table B11, below, lists the Toledo and Marblehead lake levels for these events. During the November 1972 flood, 600 persons were evacuated, over 2,000 residences were inundated to some degree, and property damages totalled over $7 million in Lucas County alone (Benson, 1978). In the mid-1970's, the Corps North Central Division conducted a damage survey of the Great Lakes shoreland. Based on this study, it was estimated that the accumulated flood inundation damages for the Western Shore of Lake Erie study area during the highwater period of 1972-1976 totalled over $21 million. Total average annual damages are estimated at about $1 million for the study area.





WATER LEVELS OF LAKE ERIE
DURING
STORM OF APRIL 27, 1966
FROM RECORDS OF
U.S. LAKE SURVEY

SOURCE: Post Flood Report, Storm of 27 April 1966, Lake Erie, Michigan and Ohio. Detroit District, 1966.

FIGURE B22

Table B11 - Recent High Instantaneous Levels on Lake Erie

Date	Lake Level on IGLD-1955	
	Toledo Gage	Marblehead Gage
27 April 1966	575.64	572.74
14 November 1972	575.98	575.18
9 April 1973	576.67	574.87
8 April 1974	576.58	575.23
14 April 1980	576.68	574.38

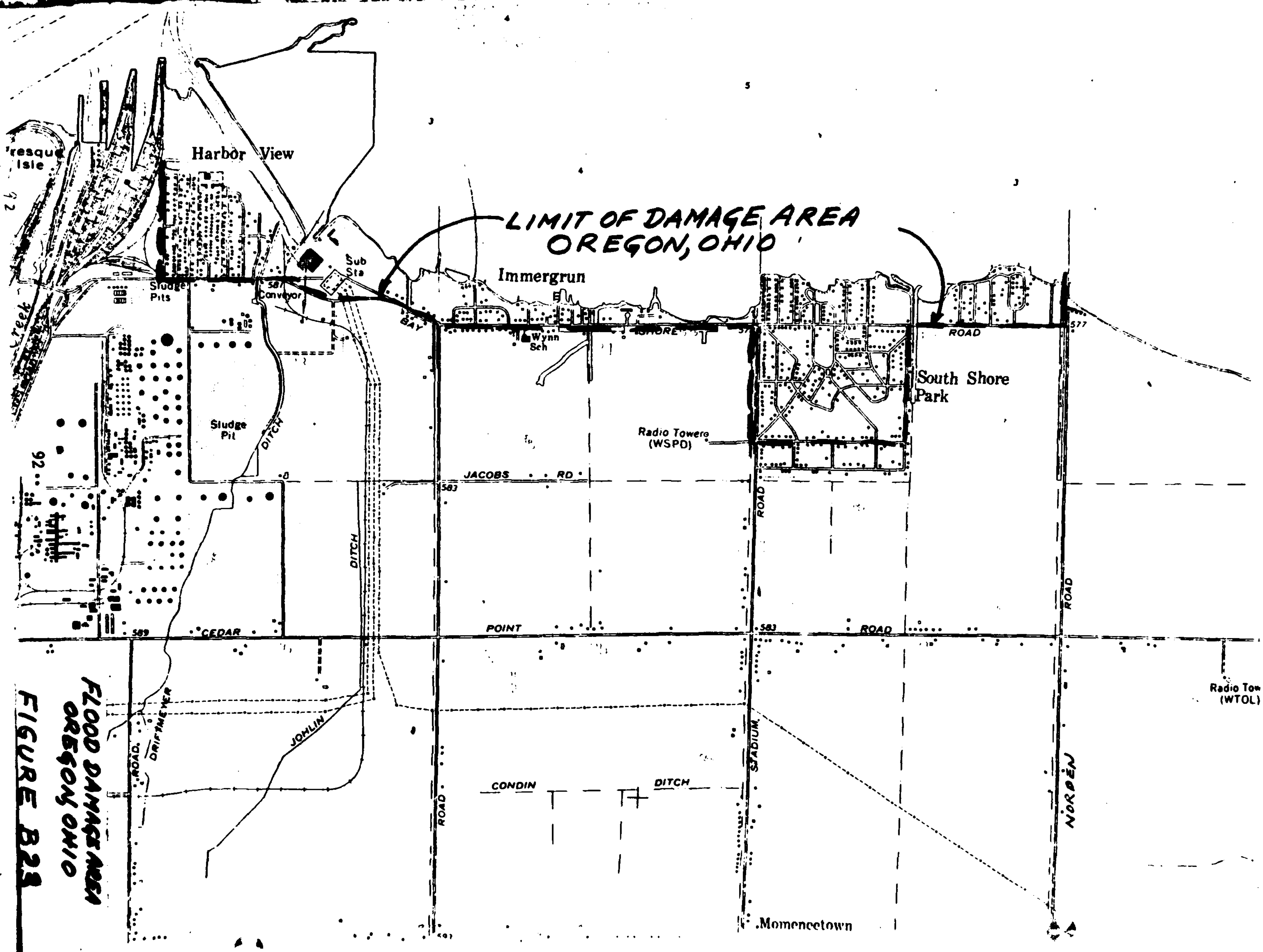
The specific flood problem areas that have been identified during the course of this Stage 1 investigation are shown on Figure B[illegible]. A brief description of the flooding problem in these areas is provided below.

1. Washington Township, Lucas County, Flooding - This problem area is located on the west bank of the Ottawa River along Shoreland Drive between Summit Road and the Ohio-Michigan line. Based on interviews with residents and observations, approximately 20 permanent residences are affected by flooding from the Ottawa River to some degree. These homes are typically 7 to 10 feet above the average Lake Erie level and experience flooding only during high lake levels caused by wind setup in Maumee Bay. The shoreline is generally protected against erosion by low walls constructed by the owners. Although the area has been flooded three times since 1965, the flood damages have generally been of the nuisance type requiring back yard cleanup.

No detailed damage surveys were conducted in the Washington Township area during this study because of the limited nature of the flooding problem. The obvious solution to this flooding problem would be construction of about 1 mile of armored dike with crest elevation of about 582 IGLD, riverward of the homes; and such construction would not be economically justified, and, in all likelihood, unacceptable to the residents. No further consideration will be given to providing flood protection in Washington Township because of the limited extent of flooding, minimal flood damages caused, and obvious lack of economic justification of such works.

2. City of Oregon, Lucas County - This flood problem area encompasses about 3.1 miles of Lake Erie shoreline immediately to the east of Toledo. It is bounded on the west by the community of Harbor View, on the east by Norden Road and Maumee Bay State Park, and on the south by Jacobs Road, as shown on Figure B23, following.

Development is predominantly residential and concentrated in the communities of Harbor View, Immergrun, and South Shore Park. Based on the 1979 damage survey conducted by Buffalo District, approximately 215 residential units and three commercial units would be affected by the 100-year Lake Erie flood level of 576.4 IGLD (see Appendix A for detailed damage and flood level data



FLOOD DAMAGE AREA
OREGON, OHIO

FIGURE B23

for this area). Zero damage is at elevation 574.0 IGLD, which occurs on the average of once every 2 years. The average value of structures in this reach is approximately $25,000, and the estimated average annual flood damages are approximately $27,500 on 1979 price levels.

Damage from shoreline erosion has been significantly reduced recently because of the addition of shoreline protection over much of the area. However, certain unprotected areas are still classified as having rapid recession rates.

Preliminary design and cost estimates for flood protection at Oregon were prepared and are discussed in the following section, Section C.

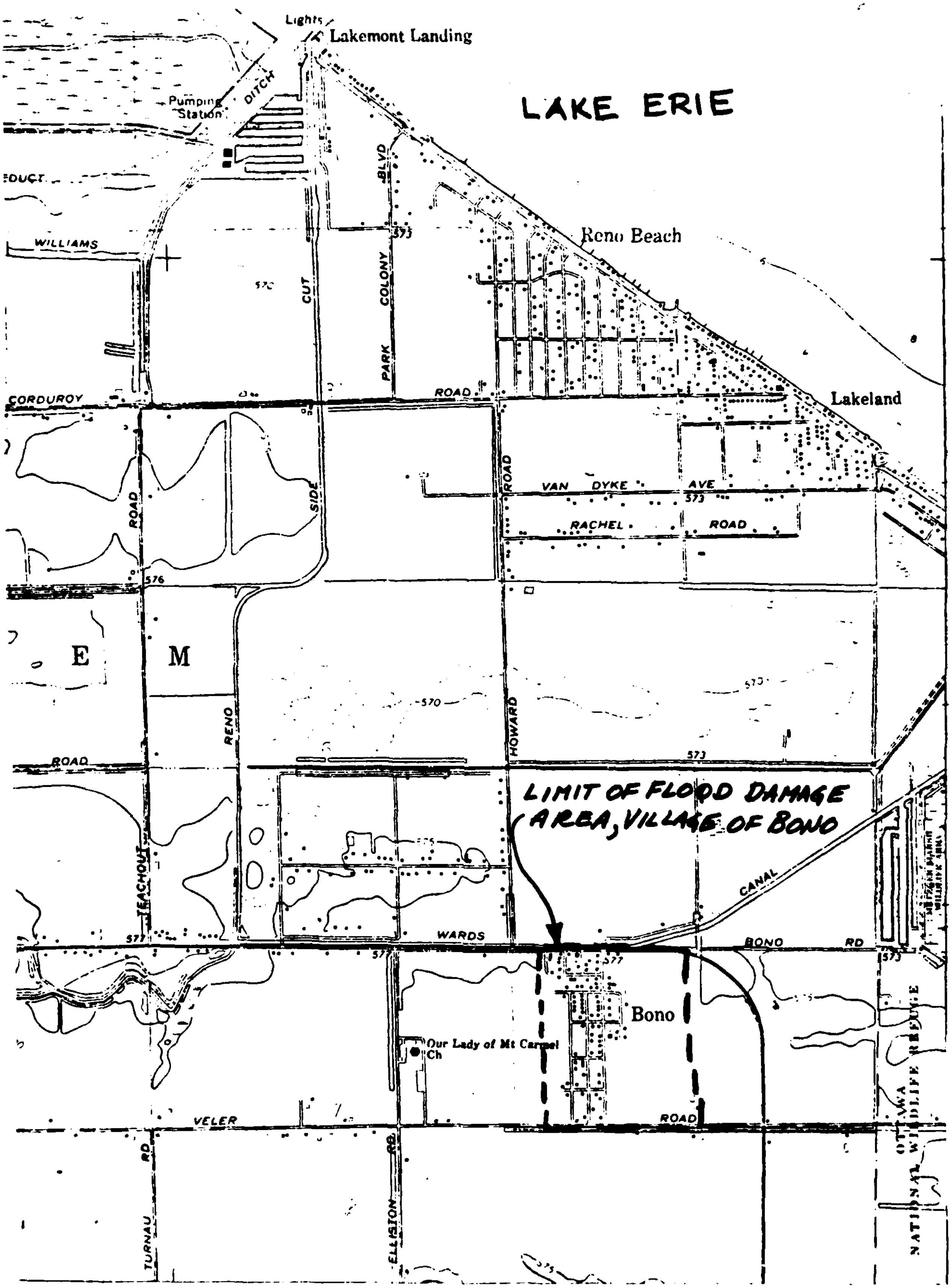
3. Village of Bono, Lucas County - The village of Bono is located immediately south of Reno Beach and approximately 2 miles inland from Lake Erie, as shown on Figure B24. Flooding in Bono has occurred in the past when high Lake Erie levels back up into Wards Canal and overtop Bono Road (Ohio Route 2) to the north of Bono. Ohio Route 2 was raised to about elevation 576.5 in the early 1970's. With an estimated instantaneous lake level of approximately 576.4 IGLD for the 100-year flood event, direct flooding of the 70 dwellings and seven businesses is presently remote. Localized flooding from interior runoff has essentially been eliminated by installation of a pump at Main Street and Route 2 about 10 years ago.

A preliminary survey of the area was performed by Toledo Projects Office personnel for this Reconnaissance Study (see Exhibit G10 of Appendix G for survey information). From this survey, it is unlikely that any of the 70 residential units and seven commercial units would be affected by flooding from Lake Erie. The average value of residential structures in Bono is estimated at about $17,000. With the average first floor elevation at about 576.5 IGLD, average annual structural damage and damage to contents would be minimal. The preponderance of the flood damages, if flooding did occur because of a very rare event or pump failure, would be limited to cleanup and landscaping. Based on this cursory evaluation, it is concluded that no further consideration should be given to the flood problem in Bono at this time.

4. Locust Point, Carroll Township, Ottawa County - Locust Point, shown on Figure B25, is located immediately east of the mouth of Turtle Creek and Crane Creek State Park. Development at Locust Point is concentrated along approximately 2,500 feet of shoreline. The residential dwellings in this area number about 135, and vary in value from about $10,000 to $50,000 with the average value between $20,000 and $25,000.

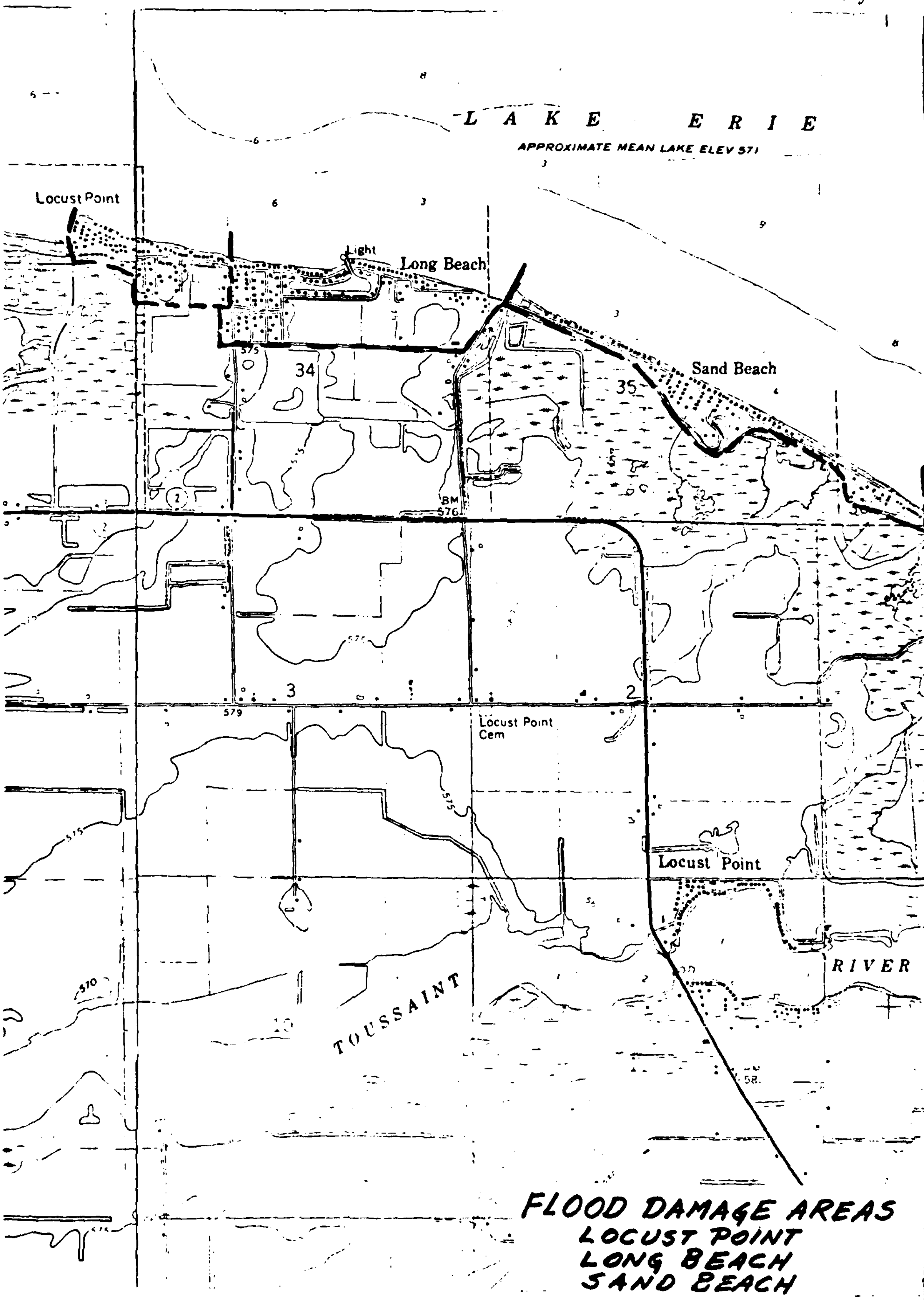
The first floor elevations of these dwellings vary between elevation 575.5 and 577.5 IGLD and the existing ground elevation is about elevation 575. The estimated instantaneous 100-year Lake Erie level at this location is 576.0 IGLD. At this elevation, approximately 131 residences would be affected by flooding to some degree, and about 96 dwellings would experience first floor flooding.

A preliminary flood damage analysis was performed for the Locust Point development (see Appendix A). From these results, the average annual flood



FLOOD DAMAGE AREA
BONO, OHIO

FIGURE B24



LAKE ERIE
APPROXIMATE MEAN LAKE ELEV 571
Locust Point
Light
Long Beach
Sand Beach
34
35
BM
576
3
2
579
Locust Point
Cem
Locust Point
RIVER
TOUSSAINT
575
570
FLOOD DAMAGE AREAS
LOCUST POINT
LONG BEACH
SAND BEACH

FIGURE B 25

damages for Locust are estimated at about $26,000. Because of the large number of residences that are susceptible to first floor flooding and the significant average annual damages sustained, preliminary plans of improvement for protecting Locust Point were prepared. These plans are discussed in Section C, following.

5. <u>Long Beach, Carroll Township, Ottawa County</u> - The Long Beach development abuts Locust Point to the west as shown on Figure B25. Approximately 130 residential dwellings are located in this community. These dwellings are typically in the moderate-to-medium price range and are generally year-round residences.

Development is well concentrated along approximately 4,000 feet of Lake Erie shoreline, except at the extreme westerly end where it extends inland about 1,000 feet. Existing ground is generally between elevations 575 and 580 and the first floor elevations vary between 575.1 and 578.9 IGLD. One resident stated that this area has not sustained extensive flood damages in the past, and in the last 10 years the worst condition he experienced was about 1 inch of water on his first floor in the spring of 1974. Most recently, in May 1980, water rose to about 1 foot above the east-west road but quickly receded and little damage occurred.

A field and damage survey of the Long Beach area was conducted by Buffalo District in February 1980 (see Appendix A). Based on an analysis of these data, and related stage-frequency for Lake Erie, 52 of the 130 homes would experience first floor flooding for the 100-year event (open-coast Lake Erie level = 578.8 IGLD), and the resulting average annual flood damages are estimated at $34,600. Preliminary plans of improvement were formulated for Long Beach to determine the feasibility of providing flood protection thereat. These plans are discussed in Section C, following.

6. <u>Sand Beach, Carroll Township, Ottawa County</u> - The community of Sand Beach is located immediately to the east of Long Beach and is the easterly most development in the Locust Point-Long Beach-Sand Beach residential complex (see Figure B25). As with the other two communities, the Sand Beach development occupies a narrow strip of slightly elevated Lake Erie shoreline with an expansive wetland/marsh to the south.

There are about 100 dwellings at Sand Beach. These structures are typically low-to-moderately priced frame residences, with expensive year-round homes interspersed.

During the recent extreme high water period of 1972-1974, about 15 lakefront homes were destroyed. Since that time, the local Conservancy District has constructed embankments at the end of Division Street to prevent water from entering the development from the marshlands to the rear, and thus alleviate flooding within the development from the rear. In addition, recently instituted building codes require that new structures on the lakefront be constructed above elevation 580.0 and those away from the lake be constructed above elevation 578.0.

Preliminary field and damage surveys were conducted in the development in February 1981 to obtain an approximation of the average annual flood damages. The existing ground in this area varies between 575 and 580. The first floor elevation of the residential units is generally between 575.5 and 578.0, and approximately 40 homes would experience first floor flooding during an occurrence of the 100-year flood (100-year open-coast Lake Erie elevation = 578.8 IGLD). The estimated damage for the 100-year event is about $400,000, and estimated average annual flood damages for the area are $28,600.

Preliminary design and cost estimates for flood protection at Sand Beach were prepared and are discussed in the following section, Section C.

7. City of Port Clinton and Vicinity, Ottawa County - Port Clinton, with a 1970 population of 7,202, is the second largest city in the study area. An in-depth analysis of the flood problem was conducted for this area because of the relatively high density of development and its large extent. The field surveys and determination of average annual flood damages were prepared over a period of several months during the summer of 1979. (Refer to Appendix A for technical details on the flood damage analysis.)

A total of about 5 miles of Lake Erie shoreline was surveyed in the Port Clinton area. This area is bounded on the west by a trailer park approximately 9,000 feet west of the mouth of the Portage River and on the east by the westerly boundary of Catawba Island, as shown on Figure B26. Development in the flood plain is both residential and commercial, with approximately 670 residential units and 87 commercial units affected by flooding to some degree. Initial flood damage occurs at approximately elevation 572.0 IGLD, and the estimated total flood damages (residential, commercial, and public) and other damages at the 100-year Lake Erie level of 576.0 (excluding wave effect) would be about $400,000. For this condition, an estimated 115 permanent residences and 103 mobile homes would sustain first floor flooding. Total average annual flood damages, including the effects of wave action, are estimated at about $172,000 (January 1980 price levels) for the 5-mile reach in Port Clinton and vicinity.

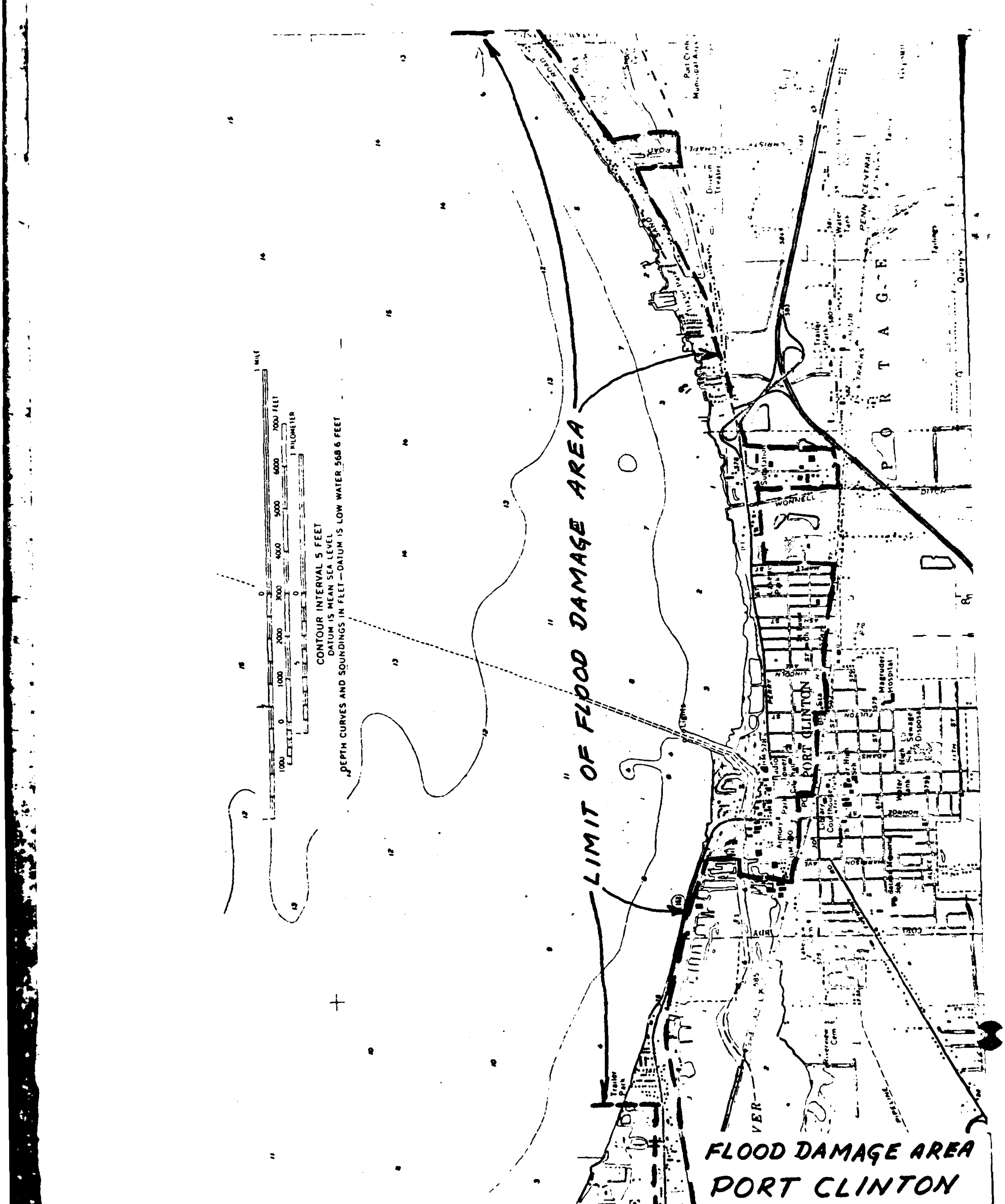
Preliminary design and cost estimates for flood protection at Port Clinton were prepared and are discussed in the following section, Section C.

8. Other Flood Problem Areas:

a. Interior Agricultural Lands, Lucas and Ottawa Counties - The following provides a summary of the agricultural damage analysis presented in Appendix B, "Economics Studies." For this preliminary analysis, the study area was subdivided into the following three reaches for agricultural purposes:

Reach X - Between Locust Point and Marblehead, Ottawa County.

Reach Y - Between Cedar Point, Lucas County, and Locust Point, Ottawa County.



LIMIT OF FLOOD DAMAGE AREA
FLOOD DAMAGE AREA
PORT CLINTON
CONTOUR INTERVAL 5 FEET
DATUM IS MEAN SEA LEVEL
DEPTH CURVES AND SOUNDINGS IN FEET—DATUM IS LOW WATER 568.6 FEET
PORT CLINTON
P O R T A G E
WONNELL
PENN CENTRAL
Magruder Hospital
Courthouse
Trailer Park

FIGURE B26

Reach Z - Between the city of Oregon and Cedar Point, Lucas County. Of the total acreage under cultivation, an estimated 14,140 acres would be flooded during an occurrence of the 100-year flood event with more than 8,700 acres flooded in Reach Y. The principal crops grown in the study area are soybeans, corn, and wheat, with lesser amounts of hay and sugar beets. Based on the preliminary damage analysis performed, the estimated total average annual agricultural damages for the entire study area is about $706,000, distributed by reach as follows:

Reach	Average Annual Agricultural Damages (Without Protection)
X	$163,100
Y	499,340
Z	43,330
Total	$705,770

A significant portion of these agricultural lands are presently protected against flooding by an intricate system of earth dikes and appurtenant interior drainage systems and pumping stations to handle local runoff. These facilities were, for the most part, constructed by individual landowners.

A cursory analysis was undertaken to determine the economic viability of supplementing the existing system by constructing approximately 33 miles of shoreline dike that would provide flood protection to agricultural lands and residential and commercial developments in addition to providing shoreline erosion protection. The first cost of this protection would be approximately $100 million, and annual charges, including operation and maintenance, would be about $8 million (7-3/8 percent interest rate and 50-year project life). Based on information available from the Great Lakes Shoreline Damage Study completed by the North Central Division of the Corps in 1979, the estimated total annual damage for the Western Lake Erie Shore study area (Reach No. 3002 in the North Central Division study) would be approximately $1.2 million. This value is reasonably consistent with the damage determinations from the Western Lake Erie Shore Study that include $706,000 for agricultural flood damages and about $300,000 for flood damages in the urbanized areas at Oregon, Locust Point, Long Beach, Sand Beach, and Port Clinton. Assuming that there are no residual damages for this dike plan, annual benefits would be $1.2 million. With annual charges of $8.0 million and annual benefits of $1.2 million, the benefit-to-cost ratio would be less than 0.2. On this basis, it is concluded that protection of agricultural lands against flooding from Lake Erie would not be economically justified even if benefits are added for protecting urbanized areas and preventing shoreline erosion.

The only apparent viable plan to protect agricultural lands is by diking around the periphery of individual fields as is currently practiced in the area. Such construction should be undertaken by the individual landowner with appropriate assistance from the U.S. Department of Agriculture. Therefore, it is concluded that no further consideration should be given to protecting agricultural lands under this study authority at this time.

b. Shoreline Between Toussaint and Portage River, Ottawa County - This reach of shoreline is relatively undeveloped except in the vicinity of Camp Perry. The remainder is primarily wetland/marsh area, including the Ottawa National Wildlife Refuge near the easterly limit of this reach.

Local interests indicated that a series of jetties generally at the mouths of existing streams would be beneficial in reducing shoreline erosion, provide better drainage for the area by reducing shoaling at the mouth of the streams, provide increased protection for recreational boaters, and encourage expansion of existing marinas in the vicinity of the proposed jetties (see Inclosure 3 of Exhibit G7, Appendix G).

A site inspection was made of the area, and it was concluded that such construction would do little to reduce the minimal flood damages that occur and although the jetties would provide some localized accretion updrift of the jetties, erosion downdrift would be aggravated. No further consideration was given to jetty construction in this 6-mile reach of Lake Erie shoreline.

Lake Level Regulation

As a result of high levels of Lake Erie in the early 1970's, the International Joint Commission established an International Lake Erie Regulation Study Board in 1977 to investigate the feasibility of limited regulation of Lake Erie. The regulatory works would be constructed near the upstream end of the Niagara River in Buffalo, NY. These works, if constructed, would provide increased outflow capacity from Lake Erie during periods of high levels. The result would be to reduce the levels, decreasing the amount of flooding and erosion along the shoreline of Lake Erie.

The preliminary findings of this study were that, although limited regulation of the levels of Lake Erie would benefit the coastal zone and recreational beach interests, these benefits would be more than offset by losses to commercial navigation, recreational boating and hydropower. A copy of these findings, dated August 1980, is provided as Exhibit G8 of Appendix G.

Recreational Navigation

Recreational boating is an important industry along the 60-mile study reach between the Michigan-Ohio line and Marblehead, OH. This area contains six major harbors/bays where marina development is prominent and a total of over 150 marina facilities, providing more that 10,000 slips, is present. The major marina developments are at East Harbor (approximately 1,900 slips), West and Middle Harbors (2,400 slips), Put-in-Bay (600 slips), Catawba (2,100 slips), Port Clinton (2,200 slips), and Toledo Harbor and immediate surroundings (1,000 slips). The recreational fleet utilizing these slips is primarily in the 16 to 25-foot class (57 percent) and the 26 to 35-foot class (33 percent).

Local interests have stated a strong need for additional recreational boating facilities in this reach of Lake Erie Shoreline. As part of the Congressionally authorized Lake Erie Coast Small-boat Harbor Study, the Buffalo District contracted with Midwest Research Institute (MRI) to determine the recreational boating facility needs on Lake Erie. In the Draft Final Report dated 31 October 1980, MRI indicated a 1985 need for approximately 1,900 additional slips in this study reach of Lake Erie.

Because the Buffalo District presently has the authority to study the potential for Federally-constructed small-boat harbors under the Lake Erie Coast study authorization, no consideration will be given to such developments in this Western Lake Erie Shore study.

Fish and Wildlife

Fish and wildlife resources of Western Lake Erie and its shoreline are recognized for their food, aesthetic, and recreational value. Their coastal habitats are important; therefore, the protection and management of the fish and wildlife resource is dependednt upon conserving and/or improving these habitats. Because of their nature, certain habitats are more significant and productive than others and need more specific attention. The loss of these significant habitats, which serve as breeding or nursery areas, or temporary resting sites for migratory waterfowl, may be a greater threat to the survival of a population than other less productive habitat. The loss of these significant habitats is of national and regional concern.

Along the Western Basin of Lake Erie, wetlands are the type of habitat which have been most adversely impacted. This has resulted from dredging and filling operations, and related changes in land use. The losses that have occurred in the coastal zone of the study area are primarily due to agricultural, residential, and recreational development, although utility construction and commercial development are also contributory. Fortunately, a considerable amount of the wetlands in the Western Basin are publicly owned and effectively managed by Federal and State agencies. However, a significant portion of the remaining wetlands are privately owned. Although people are becoming more aware of the value of wetlands, adequate incentives are not presently available to encourage private land owners to preserve them. Removal of upland habitat for development and agriculture can affect wetlands by altering runoff patterns and rates so that water levels and temperatures change; and streambank erosion and sedimentation increase. Further, upland and shoreline changes can silt in fishery spawning habitats. Shoreline erosion can also produce similar adverse effects on habitat. It can also breach barrier beaches which protect wetlands.

Unplanned Development

Much of the development along the shoreline of Lake Erie has been unplanned and uncontrolled. The shoreline in the Western Basin is no exception. Barrier beaches, which play an important part in the land/water interface, have in places succumbed to the pressures of development. Areas such as the Reno Beach-Howard Farms development, and the reach between Locust Point and Sand Beach are such locations. In many cases, homes have been built within a few feet of the water's edge, requiring substantial investment in protective structures to ward off the forces of nature. Some of these battles have been won - others lost. Until recently, building codes have not been used to provide adequate height and setback needed to prevent wave and flooding damage.

Much of this uncontrolled development has meant the loss of not only private property, but also a vast loss of wetlands. In some areas, developments have been so haphazard that they have become aesthetically unpleasant. Individual shore protection has contributed to this condition.

In recent years, a greater general awareness of, and greater sensitivity to, our natural and social environments have produced inroads that should ultimately lead to acceptance of planned development as a desirable objective. The Ohio Coastal Zone Management Program, which is administered by the Ohio Department of Natural Resources, is one such possible vehicle to wise and beneficial use of the coastal zone, if implemented by appropriate State legislation. Compliance with the requirements of the Federal Flood Insurance Program will further this goal. Very active agricultural programs by the Water and Soil Conservation Districts in Lucas and Ottawa Counties provide the technical management and administrative guidance needed for agricultural development and enhancement that is compatible with other developmental preservation and enhancement goals established for the coastal zone.

PLANNING CONSTRAINTS

Prior to defining the plannning objectives for the study, it is essential to identify constraints which might impose restrictions on the planning process. These constraints, be they legal or public policy, could be of such importance that violation would compromise the validity of the entire plannning effort. As limitations, they cut across a broad spectrum of concerns, including natural conditions, economic limitations, technological state-of-the-art, and legal constraints.

In evaluating the alternative plans which have been formulated, consideration must be given to, and tradeoffs made between, the four accounts of National Economic Development, Environmental Quality, Regional Economic Development, and Other Social Effects. For this study, the general constraints are:

- The area of analysis is limited to the specific reach of Lake Erie shoreline between the Ohio-Michigan line and Marblehead, OH, (a total distance of about 60 shoreline miles) affected by Lake Erie stages and waves.

- Planning objectives must be responded to in a practical, economical, and responsible manner.

- Local support of the plan is necessary.

- Mitigation, if any, will be required for unavoidable adverse impacts to significant or scarce resources.

- The plan must consider Other Social Effects.

One possible specific constraint to this study is the Ohio Coastal Zone Management Program. Although the program has not been finalized by ODNR at present, when completed and enacted it may be in conflict with the study objectives identified herein. Section 307 of the CZM Act requires that Federal agencies with activities directly affecting the coastal zone or proposed development projects within the coastal zone must assure that those activities and/or projects are consistent with the approved State CZM program. Therefore, close coordination must be maintained to minimize objectives of the potential for future conflict between the Ohio CZM program and this study.

The study authority emphasizes the advisability of providing beach erosion control and flood protection . . . "against storm waves and wind generated high lake levels." The District interprets this to preclude investigation of water and related land resources problems and needs, not directly related to Lake Erie. As a result, this study concentrates on the problems and needs along a relatively narrow strip of low-lying coastal plain immediately adjacent to the Lake Erie shoreline.

PLANNING OBJECTIVES

The planning objectives have been developed to address the problems, needs, and opportunities in the study area along Lake Erie with a 50-year planning horizon (mid 1980's-mid 2030's). These objectives address the resources within the context of the purpose and intent of the study authorization - i.e., plans which are formulated must address one or more of the stated objectives.

The planning objectives for the Western Lake Erie Shore Feasibility Study are as follows:

- Contribute to the stability of the soils subject to erosion from Lake Erie;

- Contribute to the reduction of flooding due to high Lake Erie levels for economic stability and protection of property for the 50-year planning horizon through the mid 2030's;

- Contribute to the water, and related land-based recreation resources for picnicking, swimming, fishing, camping, nature studies, hiking, bicycling, and golfing through the mid 2030's;

- Contribute to the Federal and State listed cultural resources for educational, scientific, and aesthetic purposes;

- Preserve, protect, and enhance fish and wildlife habitat along the 60-mile reach of Lake Erie shoreline in the study area; and

- Promote the utilization of Lake Erie.

As the study progresses, these planning objectives will be continuously reanalyzed and refined as appropriate to reflect new problems and needs that surface. Each plan that is formulated in this, and subsequent stages of the study, will be evaluated as to whether and how well it addresses these objectives.

Agriculture provides a significant economic base in the study area. Traditionally, the Soil Conservation Service of the U. S. Department of Agriculture has served as the action and advisory agency in implementation of Federal programs to serve the agricultural need. Such has been the case in Lucas and Ottawa Counties. Flooding of agricultural lands in the study area can be aggravated by high Lake Erie levels. However, since the only viable method of protecting these agricultural lands from flooding is constructing

levees and appurtenant drainage works around individual plots of 50 to 100 acres, it is concluded that participation in such activities is most appropriate for an agricultural agency such as the Soil Conservation Service.

The National Objectives relating to the planning and development of the Nation's water and related land resources were previously identified. These goals are National Economic Development (NED) and Environmental Quality (EQ). The study, or planning objectives, are national, State, and local water and related land resource management problem needs specific to the given study area that can be addressed to enhance NED and/or EQ. As such, the planning objectives are the means of bridging the gap between the universality of the two national goals and the specificity of the problems in the given area. While it is not possible to directly plan for enhancing NED by increasing the Nation's output of goods, and improving national economic efficiency, it is possible to contribute toward these needs and NED, for example, by reducing damage from erosion and flooding along the 60-mile reach of Lake Erie shoreline in the study area.

The purpose of planning objectives is to provide sufficient specificity to direct the study in a meaningful manner. These objectives will be used to guide the formulation of alternative plans for the entire study area and also for site-specific locations within the study area. They are also used in evaluation, when it is necessary to determine the degree to which each plan fulfills the requirements of each objective as a basis for reiteration.

The planning objectives for the Western Lake Erie Shore Study have been developed in conformance with:

a. The problems, needs, and opportunities that have been identified in the study area;

b. The mission of the U. S. Army Corps of Engineers relative to the planning, management, and development of the Nation's water and related land resources;

c. The specific problems and needs which the U. S. Congress has directed the study to address; and

d. The policy initiatives that are under consideration by the Ohio Coastal Zone Management Program, as they are developed.

SECTION C
FORMULATION OF PRELIMINARY PLANS

Having obtained the necessary background on the resources, problems and needs, and public attitudes toward general solutions in the study area through the planning task of Problem Identification, the process of Plan Formulation can be initiated. In this process, plans that meet the planning objectives are formulated and screened. Unacceptable alternatives are systematically eliminated, and viable alternatives are assessed and evaluated to assure selection of the best plan of improvement.

The purpose of this section is to present the results of the formulation effort performed for Stage 1. As previously discussed in Section B, a number of individual problem areas within the study area have been identified. Preliminary investigations (i.e., design, cost estimate, economic analysis, etc.) were conducted in formulating alternative plans of improvement for most of these problem areas. Both structural and nonstructural solutions were considered during the formulation process. The "No-Action" or "Do Nothing" plan will be carried forward through the entire feasibility process to be used as the "basis of comparison" with considered structural and nonstructural plans, and for designation as the "Selected Plan" in the event that no other plans are found to be feasible.

It should be recognized that a prime objective in Stage 1 formulation and evaluation is to eliminate from further consideration those water resources projects that obviously would not meet the requirements of engineering, economic, environmental, and/or institutional feasibility. Only those potential projects that appear to have a reasonable probability of implementation should be carried forward into Stage 2 for more detailed study. For this reason, and because of the large study area and numerous individual problem areas involved, the designs, cost estimates, and benefits are generally preliminary values with an accuracy of $\pm$ 10 to 20 percent. To account for the preliminary nature of these values, plans of improvement that have a benefit-to-cost ratio greater than 0.9 will be recommended for further study in Stage 2, assuming there are no obvious overriding environmental and/or institutional constraints.

MANAGEMENT MEASURES

The following are management measures which have been identified as having some potential for meeting the established planning objectives. The measures are technical and institutional means of reducing shoreline damage due to erosion and flooding. These measures are divided into two categories - structural measures and nonstructural measures. For purposes of definition, "structural measures" are improvements that would be constructed to act directly on the water to change its direction, area of inundation, volume, stage or timing, or to dissipate its energy. Another definition would be

that structural measures are active/corrective in that they are directed at the cause of the problem. In contrast, "nonstructural measures" are actions taken directly on the land, population, or property to reduce erosion and flood damage; they are passive/preventative in that they are directed at the recipient of the problem. The structural and nonstructural measures considered are:

<u>Structural Measures</u>

- Protective Sand Beach
- Groins
- Bulkheads, Seawalls, and Revetments
- Headlands
- Floating Breakwaters
- Perched Beach
- Offshore Breakwaters
- Dikes, Levees, and Floodwalls
- Lake Level Regulation

<u>Nonstructural Measures</u>

- Floodproofing
- Evacuation
- Flood/Erosion Insurance
- Land Management (Zoning, Building Codes, etc.)

PLAN FORMULATION RATIONALE

Each alternative plan of improvement developed from the list of general management measures is subject to various formulation and assessment criteria. First, each alternative must meet certain functional and technical criteria. Most important, an alternative must be physically able to solve the particular water resource problem being addressed - i.e., shoreline erosion, flood inundation, etc. It must also be compatible with the environment of the project area. In addition, each alternative must be judged on the degree of difficulty to construct.

Each alternative must meet certain economic criteria. Project costs and economic benefits associated with each alternative must be determined, and in the general case the benefits to be realized must exceed the cost of construction to meet the requirement of economic viability. Guidelines are contained in the Water Resources Council's <u>Procedures for Evaluation of National Economic Development (NED) Benefits and Costs and Other Social Effects (OSE) in Water Resources Planning</u> (Federal Register 9/29/80).

Annual economic benefits must exceed annual economic costs unless the deficiency is the result of benefits deliberately foregone or costs incurred to obtain positive environmental quality contributions. The optimum design, from the NED viewpoint, will have the maximum average annual net benefits, and should have a benefit-to-cost ratio equal to or greater than unity.

Alternatives are also evaluated environmentally. Evaluation will be made on how the implementation of an alternative would contribute to preserving, maintaining, restoring, or enhancing cultural and natural resources.

In developing the preliminary plans for this Stage 1 study, the following technical, economic, and environmental criteria were used.

Functional and Technical Criteria

- Alternative plans must be engineeringly feasible, practicable, and sound.

- Plans must be adequate to provide a 50-year project life.

- Plans to provide shore erosion protection are designed for the 200-year coincident condition of 20-year wave and 10-year Lake Erie level.

- Plans for flood protection are designed for the 100-year Lake Erie level with associated wave runup.

- Existing facilities will be utilized to the maximum extent possible.

- For this Stage 1 effort, considered plans will be based on preliminary designs of sufficient accuracy to produce reasonable, representative quantity and cost estimates.

Economic Criteria

- Costs presented in this Stage 1 document are on January 1981 price levels, unless otherwise noted. Annual costs and benefits are based on a 50-year amortization period and 7-3/8 percent interest rate, unless otherwise noted.

- Benefits will be derived from a comparison of the projected "without project" conditions to the projected "with project" conditions.

- Tangible benefits should exceed project economic costs (B/C >1) unless the deficiency is the result of NED benefits foregone or costs incurred to obtain positive EQ contributions. However, since the designs and benefit evaluations for this Stage 1 study are considered to be preliminary, further study will be recommended for those problem areas where the benefit-to-cost ratio is greater than 0.9 to insure that economically feasible improvements are not eliminated because of the preliminary nature of the analysis.

- Each separable unit of improvement must provide benefits at least equal to its costs.

Socio-Economic and Environmental Criteria

The criteria for socio-economic and environmental considerations in water resources planning are prescribed by the National Environmental Policy Act of 1969 (P.L. 91-190) and Section 122 of the River and Harbor Act of 1970

(P.L. 91-611). These criteria require that all significant adverse and beneficial environmental, social, and economic effects of planned developments must be considered and evaluated during formulation. In addition, Executive Order 11990, dated 24 May 1977, directs that each agency shall provide leadership and take action to minimize the destruction, loss, or degradation of wetlands and to preserve and enhance the natural and beneficial values of wetlands.

DEVELOPMENT OF ALTERNATIVE PLANS

Within the prescribed planning framework and established criteria, possible solutions to the erosion and flooding problems were developed for each specific problem area. This document presents the results of the Stage 1 evaluation. The level of study performed is consistent with the Stage 1 objective of determining the Federal (Corps) interest in performing further, more detailed studies in Stage 2. Thus, the emphasis in Stage 1 was to perform preliminary evaluations of the most reasonable structural measures, although nonstructural measures were considered where appropriate.

The general philosophy of this exercise was to use the "least-cost" method of structurally protecting each of the erosion and floodprone areas which had been identified as having sufficient damages to warrant further consideration. Thus, if, by using the least-cost method of structural protection, being conservative in estimating the cost of protection and liberal on the estimated benefits, the benefit-to-cost ratio did not exceed 0.9 (an additional degree of liberalism to insure that potentially-feasible projects are not eliminated prematurely) for the individual problem areas, those areas would be eliminated from further consideration in Stage 1.

The selection of the best measure (s) for each area was based upon its applicability to flood and/or erosion control, the design lake level and wave condition, nearshore slope, existing protection, the property elevation, and its proximity to the shoreline, and the shoreline condition. The most common structural measures considered for protection against erosion were stone revetments and protective sand beaches with offshore breakwaters. For flood control, armored dikes were the most common structural measures considered; and raising first floor elevations, floodproofing, and evacuation were the most common nonstructural measures considered.

The evaluation of the economic viability of structural shoreline protection was based on the cost of protection, the damages prevented, and the additional recreational value that would be realized. The analysis used a 50-year project life and an interest rate of 7-3/8 percent, except as otherwise noted. Erosion damages were determined using the long-term recession rates, the market value of the land and development, and the setback distance of the development. As previously discussed in Section B, flood damages were based on damage surveys of the specific problem areas conducted during this Stage 1 study, and supplemented by damage information from the Great Lakes Shoreland Damage Study prepared by the Corps North Central Division in February 1979.

Based on the results of the damage investigations presented in Section B, it was concluded that plans of improvement should be formulated for the following problem areas:

<u>Shoreline and Beach Erosion Problem Areas</u>

- Maumee Bay State Park, Lucas County

- East Harbor State Park, Ottawa County

<u>Flood Problem Areas</u>

- City of Oregon, Lucas County

- Locust Point, Ottawa County

- Long Beach, Ottawa County

- Sand Beach, Ottawa County

- City of Port Clinton and Vicinity, Ottawa County

In addition to these seven problem areas for which plans were formulated, the following problem areas that were identified by local interests were eliminated prior to formulation because site inspection and/or cursory damage evaluations indicated that damages sustained were not sufficient to warrant further consideration. Descriptions of these areas are presented earlier in Section B.

<u>Shoreline Erosion Problem Areas Eliminated Prior to Formulation</u>

- Middle Bass Island, Ottawa County

- Put-in-Bay, Ottawa County

<u>Flood Problem Areas Eliminated Prior to Formulation</u>

- Washington Township, Lucas County

- Village of Bono, Lucas County

- Lake Erie Shoreline Between Toussaint and Portage Rivers, Ottawa County

- Inland Agricultural Lands in Lucas and Ottawa Counties

The preliminary designs, costs, and economic comparisons for each of these problem areas are presented below.

MAUMEE BAY STATE PARK (Shoreline Erosion)

Maumee Bay State Park is a partially-developed 1,241-acre multi-use recreation complex located on the south shore of Lake Erie approximately

5 miles east of Toledo, OH (see Figure B8 of Section B for location). Erosion of the shoreline fronting the park is the major water resources problem at this site, and the Ohio Department of Natural Resources (ODNR) considers control thereof imperative for full development of the park to take place.

At the request of ODNR, the Detroit District of the Corps prepared a Reconnaissance Report on shore erosion under Section 103 of the 1962 River and Harbor Act (Continuing Authority Program) in November 1976. The considered plan of improvement would have provided a 3,500-foot sand beach protected by steel sheet pile groins along the westerly end of the park at a total cost of $2.7 million. Because the project cost would significantly exceed the Federal cost sharing limitation of $1 million under Section 103, ODNR subsequently requested that further study be performed under the Congressionally-authorized Western Lake Erie Shore Study which would permit greater Federal participation in cost sharing if authorized for construction by Congress. As a result, Buffalo District requested and received approval in November 1978 to continue study of Maumee Bay State Park as an interim study to the Western Lake Erie Shore Feasibility Study.

The Stage 2 study for Maumee Bay State Park was initiated in spring 1979 and completed in September 1980. Preliminary designs, cost estimates, and benefit evaluations were performed by the consulting firm of Moffat and Nichol under contract to Buffalo District and the main report was prepared by the District. Based on review comments by North Central Division, the Stage 2 Interim Report is presently being revised by the District and is scheduled for public release in the spring of 1981.

Alternative Plans of Improvement

During the initial iteration of alternatives for Stage 2, such conceptual plans as headlands, floating breakwaters, and a perched beach were eliminated for engineering, functional, safety, and/or environmental reasons. Four alternatives, including the No-Action and three structural plans, were carried forward for further consideration. These alternative plans, shown on Figures C1 through C4 following, were:

- Alternative 1: No-Action Plan

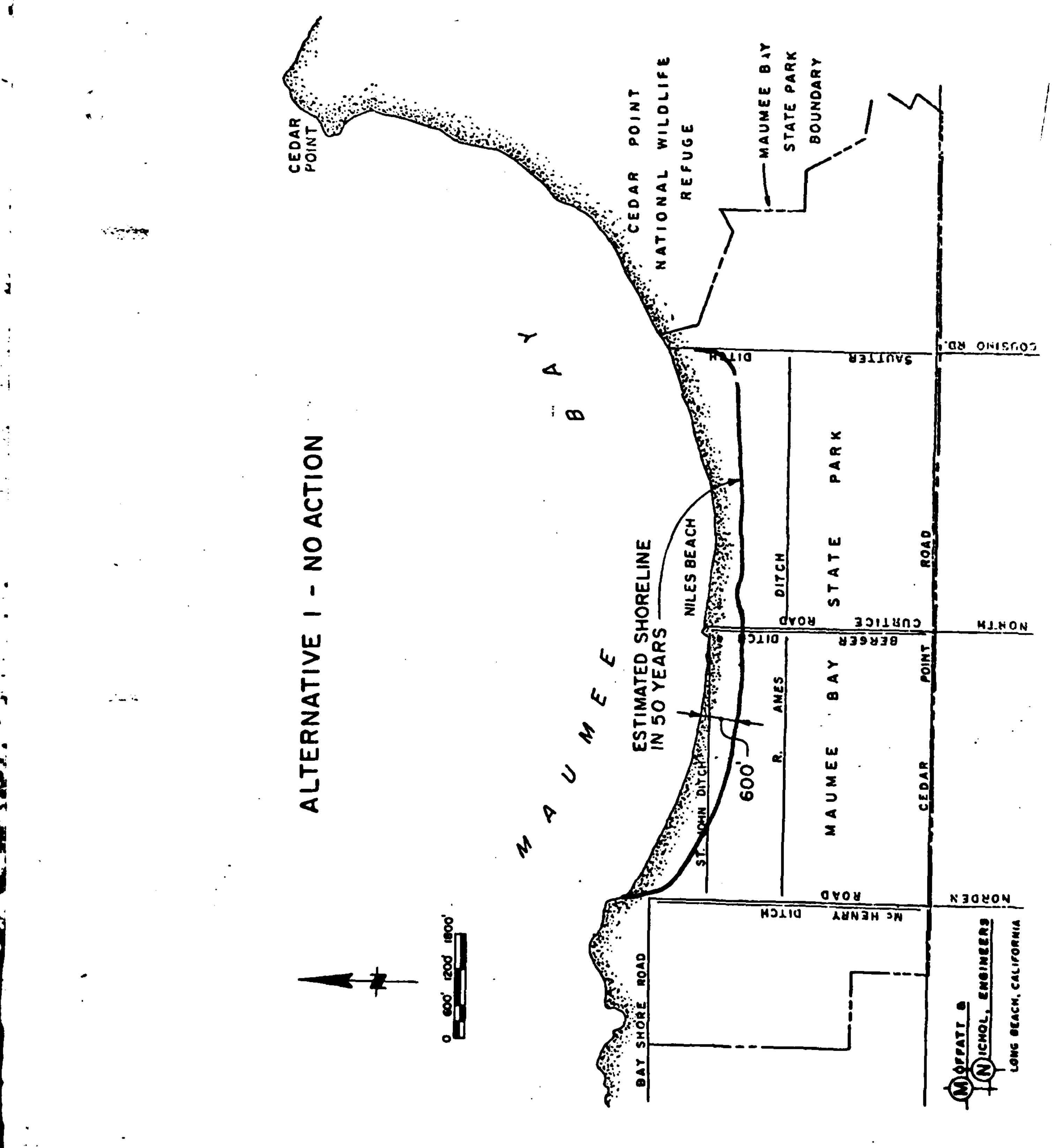
- Alternative 2: 5,500-foot Protective Sand Beach Along Westerly Half of Park and 5,500-foot Stone Revetment Over Easterly Half

- Alternative 3: Protective Beach with Offshore Breakwaters at West End and Stone Revetment at East End

- Alternative 4: Protective Beach with Groin Field at West End and Stone Revetment at East End

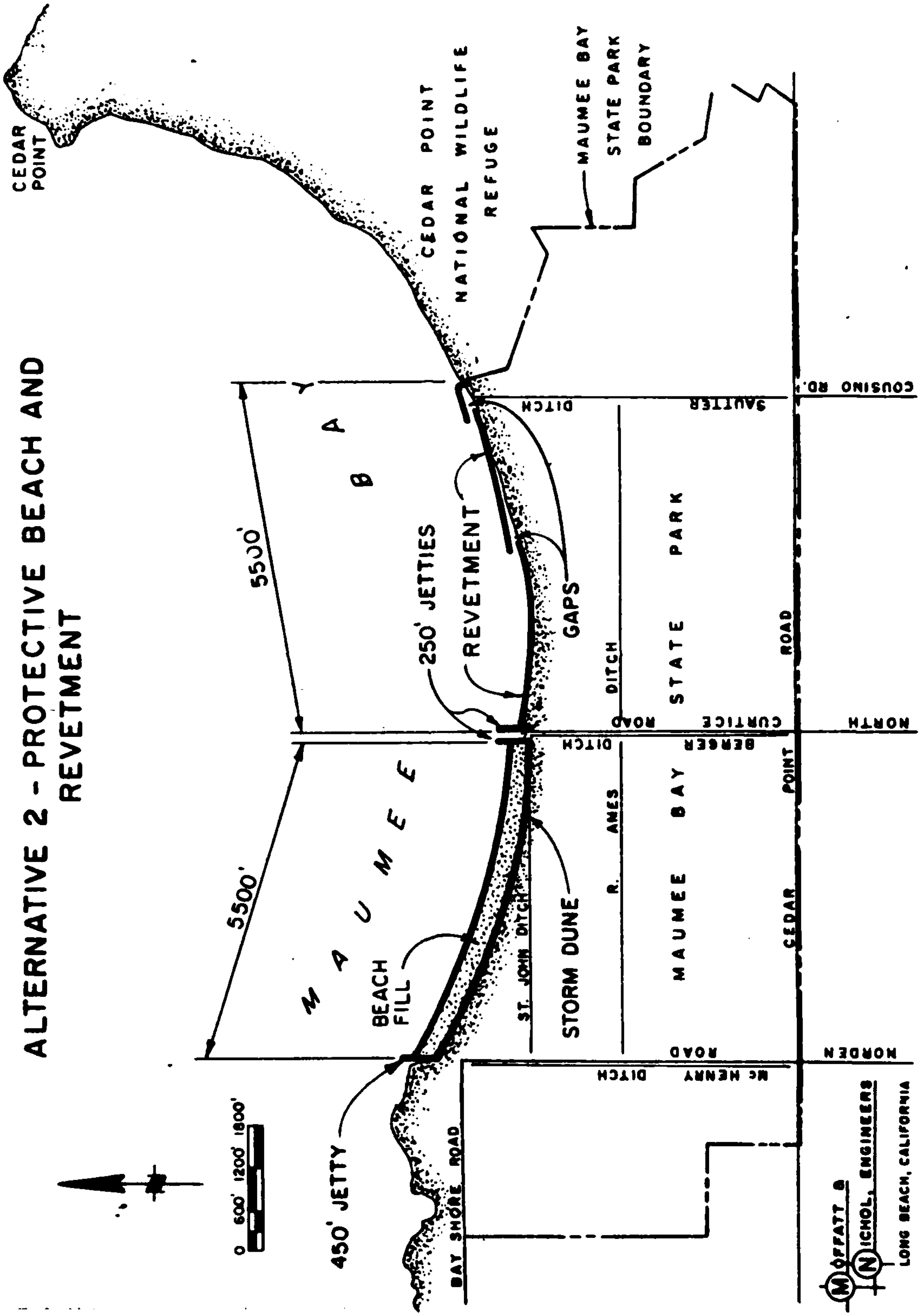
Project Costs

Preliminary designs to provide erosion protection for a 200-year coincident wave/Lake Erie water level condition, along with associated quantity and cost



ALTERNATIVE I - NO ACTION
CEDAR POINT
CEDAR POINT NATIONAL WILDLIFE REFUGE
MAUMEE BAY STATE PARK BOUNDARY
MAUMEE BAY
ESTIMATED SHORELINE IN 50 YEARS
600'
NILES BEACH
MAUMEE BAY STATE PARK
SAUTTER DITCH
COUSINO RD.
DITCH
NORTH CURTICE ROAD
BERGER DITCH
R. AMES DITCH
ST. JOHN DITCH
CEDAR POINT ROAD
NORDEN ROAD
Mc HENRY DITCH
BAY SHORE ROAD
N
0 600' 1200' 1800'
MOFFATT & NICHOL, ENGINEERS
LONG BEACH, CALIFORNIA

Figure C1



ALTERNATIVE 2 - PROTECTIVE BEACH AND REVETMENT

Figure C2

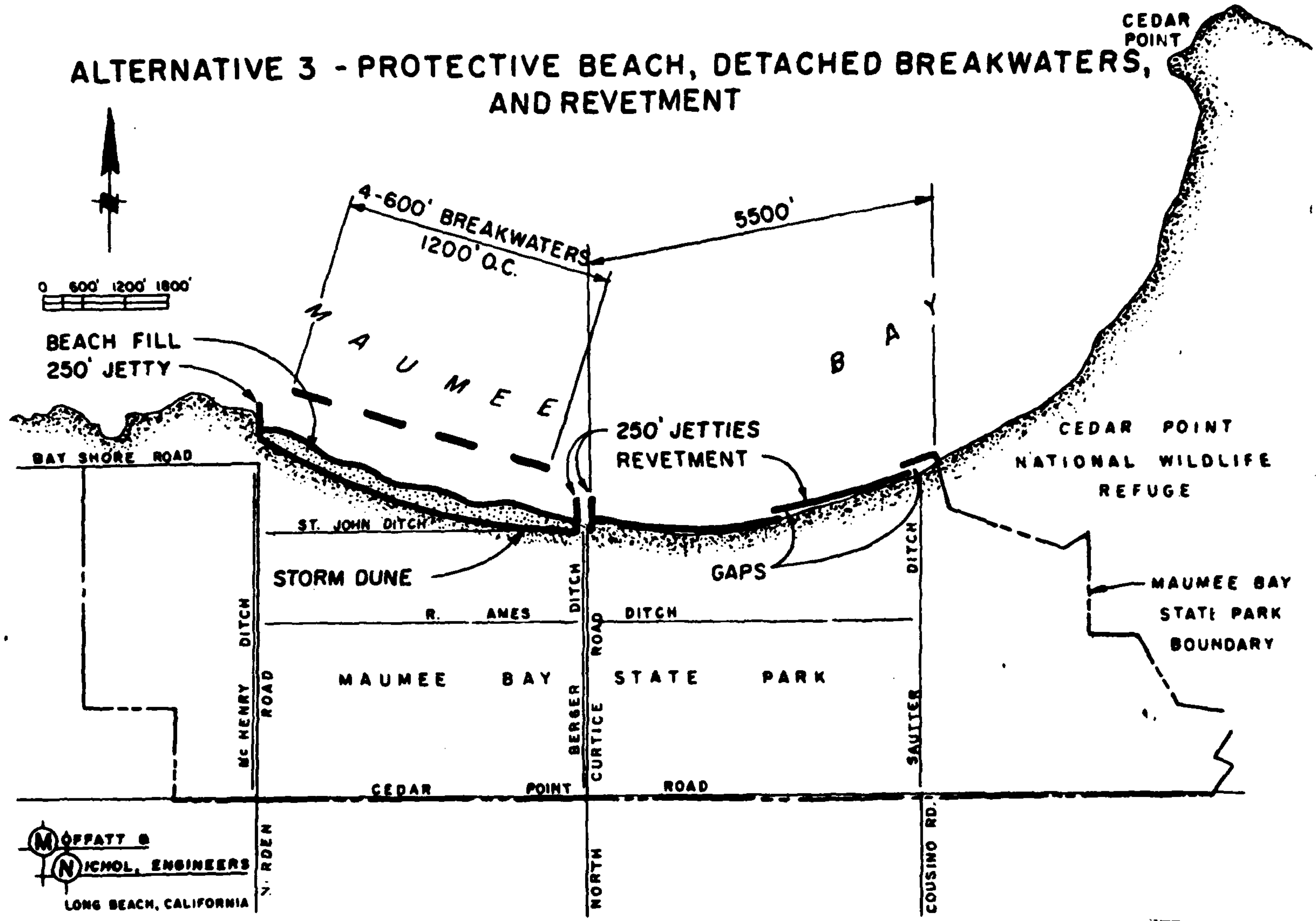

ALTERNATIVE 3 - PROTECTIVE BEACH, DETACHED BREAKWATERS, AND REVETMENT
CEDAR POINT
0 600' 1200' 1800'
4-600' BREAKWATERS 1200' O.C.
5500'
MAUMEE BAY
BEACH FILL
250' JETTY
250' JETTIES
REVETMENT
STORM DUNE
GAPS
CEDAR POINT NATIONAL WILDLIFE REFUGE
MAUMEE BAY STATE PARK BOUNDARY
BAY SHORE ROAD
ST. JOHN DITCH
R. ANES DITCH
Mc HENRY DITCH
ROAD
BERGER DITCH
CURTICE ROAD
SAUTTER DITCH
MAUMEE BAY STATE PARK
CEDAR POINT ROAD
N. RDEN
NORTH
COUSINO RD.
MOFFATT & NICHOL, ENGINEERS
LONG BEACH, CALIFORNIA

Figure C3

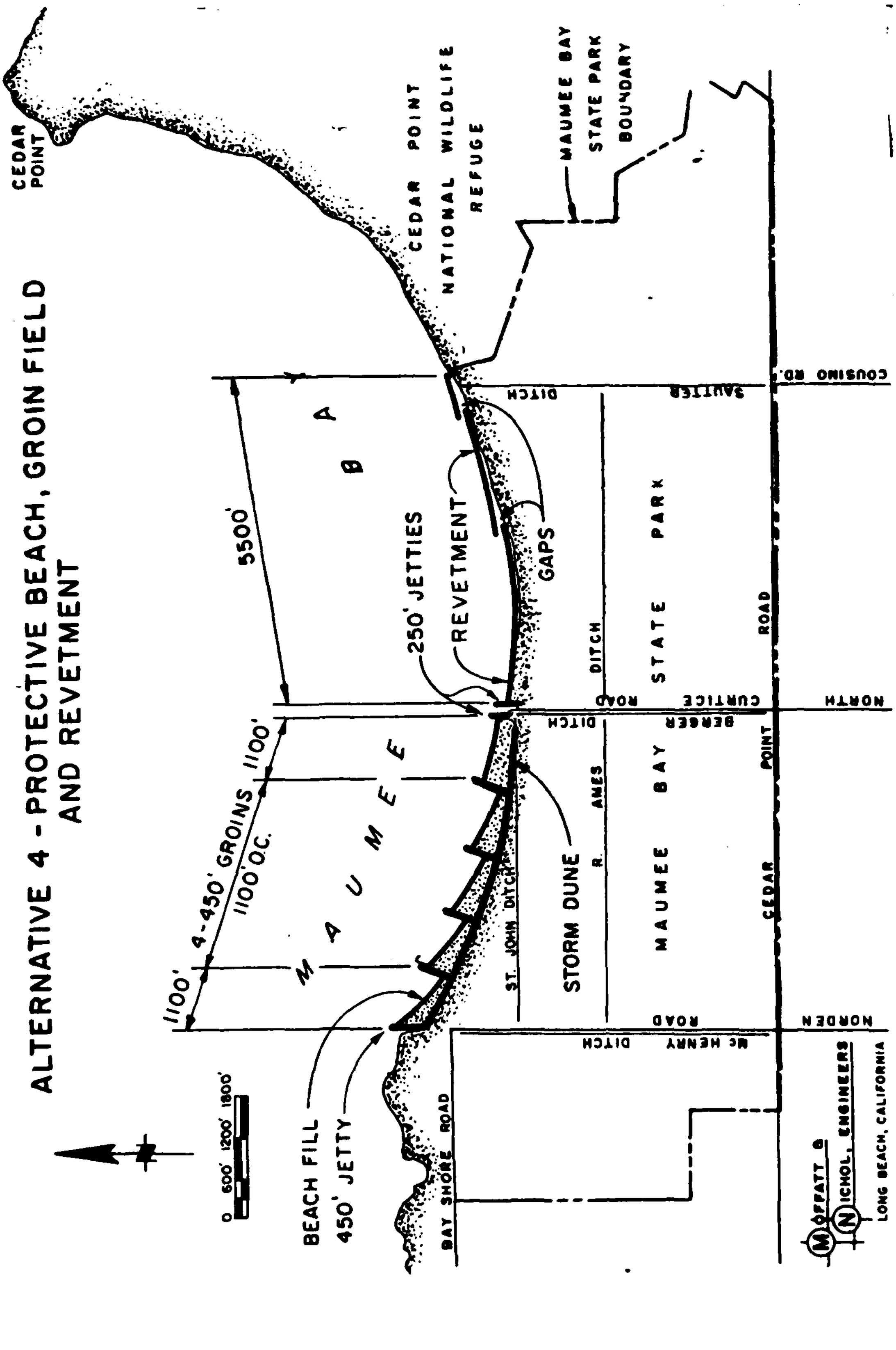

ALTERNATIVE 4 - PROTECTIVE BEACH, GROIN FIELD AND REVETMENT
0 600' 1200' 1800'
BEACH FILL
450' JETTY
1100'
4-450' GROINS
1100' O.C.
1100'
5500'
250' JETTIES
REVETMENT
GAPS
STORM DUNE
MAUMEE BAY
CEDAR POINT
CEDAR POINT NATIONAL WILDLIFE REFUGE
MAUMEE BAY STATE PARK BOUNDARY
MAUMEE BAY STATE PARK
BAY SHORE ROAD
ST. JOHN DITCH
R. AMES
DITCH
MC HENRY DITCH
NORDEN ROAD
BERGER DITCH
CURTICE ROAD
NORTH CURTICE ROAD
SAUTTER DITCH
COUSINO RD.
CEDAR POINT ROAD
MOFFATT & NICHOL, ENGINEERS
LONG BEACH, CALIFORNIA

Figure C4

estimates, were prepared for each structural plan. The basis for these designs and specifics on quantities and costs for each alternative plan are presented in Section D of the Stage 2 Report for the Maumee Bay Interim, and a summary comparison of first costs and annual charges for the alternative plans is shown in Table C1, following.

Project Benefits

The two categories of potential benefits for the Maumee Bay State Park project are: (1) Recreational benefits which are dependent upon providing a shoreline protection project that incorporates a sand beach; and (2) shoreline erosion damages prevented.

In Stage 2, it was determined that utilization of the park is highly dependent (82 percent dependency) upon providing a shore protection project that incorporates a sand beach. Based on the estimated annual park attendance attributable to the shore protection project of 820,000 persons per year, and the total average value per park participant of $2.14 (Water Resources Council's Travel Cost Method), annual recreation benefits attributable to the shore protection project were estimated at $1,755,000.

An estimated 2.8 acres of park land are lost annually due to shoreline erosion. Using an average value of $1,350/acre based on current assessed values for similar land in the area, the average annual erosion damage prevented by the shoreline protection project is about $4,000 (2.8 acres/year x $1,350/acre).

Since all three of the structural plans considered would have the same dimensions, provide the same opportunities for recreational usage, and eliminate the same amount of shoreline erosion, annual benefits for each are the same, or $1,759,000 ($1,755,000 for recreation and $4,000 for shore erosion prevented).

Economic Efficiency

Net benefits and the benefit-to-cost ratios for Alternatives 1-4 are shown in Table C1, above. From the tabulation, it is seen that all three structural alternatives (Alternatives 2, 3, and 4) are economically justified, and would provide considerable net benefits.

Comparison of Plans 1-4

The comparison of these four plans is presented in Section E of the Stage 2 Report for the Maumee Bay project. The "Summary of Effects" for the plans is provided in Table 23 of that document, and is not included herein for brevity.

Alternatives Eliminated in Stage 2

Based upon this comparison, and input from the U.S. Fish and Wildlife Service (F&WLS) and the Ohio Department of Natural Resources, Alternative Plan 4 (Protective Beach with Groins, and Revetment) was eliminated in Stage 2 for

Table C1 - Economic Comparison of Alternative Plans 1 through 4 for Maumee Bay State Park Beach and Shoreline Erosion Project[1/] (January 1980 Price Levels)

Item	Alternative 1 No-Action	Alternative 2 Beach and Revetment	Alternative 3 Beach with Detached Breakwaters, and Revetment	Alternative 4 Beach with Groins, and Revetment
	$	$	$	$
Total Project First Cost				
Federal	-	5,770,000	7,150,000	6,893,000
Non-Federal	-	2,654,000	3,214,000	3,135,000
Total	-	8,424,000	10,364,000	10,028,000
Annual Charges				
Federal	-	509,000	534,000	603,000
Non-Federal	-	238,000	251,000	282,000
Total	-	747,000	785,000	885,000
Annual Benefits	-	1,759,000	1,759,000	1,759,000
Net Benefits	-	1,012,000	974,000	874,000
Benefit/Cost Ratio	-	2.4	2.2	2.0

1/ Dollar amounts shown for Federal and non-Federal shares are based on the traditional 70 percent Federal and 30 percent non-Federal cost sharing.

the following reasons. First, the F&WLS opposed this plan because it would be most disruptive to existing littoral current and drift patterns. In addition, ODNR was concerned that scour holes would form at the head of groins and pose a hazard to unsuspecting bathers, particularly small children. Also, the District and ODNR consider the high annual nourishment costs for Alternative 4 ($138,000 annually) to be excessive, and there is a distinct possibility the required nourishment for Alternative 4 may even be higher than the qualitative estimate prepared in Stage 2.

Alternatives Warranting Further Study in Stage 3

Based on the evaluation made in Stage 2, the following alternative plans, or some modification thereof, will be considered in Stage 3 of the Interim Feasibility Report on Shoreline Erosion and Beach Restoration for Maumee Bay State Park, OH:

Alternative Plan 1 - No-Action
Alternative Plan 2 - Protective Beach and Revetment
Alternative Plan 3 - Protective Beach with Breakwaters, and Revetment

Flood Potential at Maumee Bay State Park

The average ground elevation in the park is about 574.0 IGLD. For the estimated 100-year peak level of 577.3 IGLD, the average depth of flooding for this event would be approximately 3 feet. The only practical structural measure for preventing flooding would be to construct armored dikes fronting Lake Erie and earth dikes around the periphery of the remainder of the park. These dikes would be 8 to 12 feet high, including freeboard.

The nonstructural approach to flood damage reduction was selected because: (1) The high cost for the dike and appurtenant works would not be incrementally justified; (2) such protection would destroy the existing wetland/proposed nature area at the east end of the park unless the dike was constructed landward thereof; (3) dike construction around the periphery would detract from the recreational setting in which it was placed; and (4) structural means of flood damage reduction are inconsistent with the philosophy of developing low-damage potential use such as recreation in the flood plain.

Because of the potential for flooding of the park, an item of local cooperation requiring the local sponsor to construct permanent structures and egress roads above the 100-year flood level will be incorporated into the Final Feasibility Report for the Maumee Bay Interim.

Stage 2 Recommendations

The District recommended, and received approval, to proceed with Stage 3 investigations and prepare an Interim Feasibility Report on Shoreline Protection/Beach Restoration at Maumee Bay State Park.

Stage 3, to be prepared by an interdisciplinary team of Buffalo District staff, was initiated during the second quarter of fiscal year 1981. The

Draft Stage 3 document (Milestone 6) is scheduled for completion in December 1981.

EAST HARBOR STATE PARK (Beach Erosion)

East Harbor State Park is located on the south shore of Lake Erie in Danbury Township, Ottawa County, OH, and is approximately 81 miles west of Cleveland, OH, and 45 miles east of Toledo (see Figure B8 for location).

The park consists of 1,613 acres, including 848 acres of water on West, Middle, and East Harbors. It contains 570 Class "A" campsites, several boat launching ramps, and a marina, in addition to 2 miles of sand beach. Recent high lake levels have submerged the beach and caused loss of beach material back to an existing concrete revetment. The revetment is now overtopped by waves greater than 4 feet, causing loss of fill behind the revetment. Approximately 90 percent of the beach has been closed to swimmers for the past 5 years due to unsafe conditions resulting from erosion. Park officials attribute the drop in swimming attendance from 800,000 in 1967 to about 240,000 users in 1977 to the beach erosion.

At the request of the Ohio Department of Natural Resources in 1975, the Detroit District initiated a Reconnaissance Study of the beach erosion problem under Section 103 of the 1962 R&H Act (Small Project or Continuing Authority Program). The resulting Section 103 Reconnaissance Report, dated 23 April 1980, was published by the Buffalo District. The report concluded that further study of the erosion problem was warranted, and recommended that... "no further action be undertaken under the Section 103 authorization but that further studies be implemented under the Congressionally-authorized Western Lake Erie Shore, OH, study in accordance with the desires of the Ohio Department of Natural Resources. The reason for this requested action was that the first cost of the contemplated improvements would significantly exceed the Section 103 Federal cost sharing limitation of $1 million. North Central Division concurred in this recommendation by 1st Indorsement dated 6 May 1980, and forwarded the report to the Office of the Chief of Engineers for approval. Although approval has not been provided by the Office of the Chief of Engineers to present (March 1981), the recommended action for East Harbor State Park is the same as for Maumee Bay State Park where approval to conduct that study under WLES has been provided.

Therefore, further study of the beach erosion problem at East Harbor State Park will be performed under the Western Lake Erie Shore Feasibility Study.

<u>Alternative Plans of Improvement Considered in the Reconnaissance Report</u>

Initially, consideration was given to the following alternative measures for solving the erosion problem at East Harbor State Park:

- No Action
- Vegetation in Unprotected Areas
- Groin Field
- Groin Field and Bulkhead
- Detached Segmented Breakwaters

Upon evaluation of these measures, two plans were identified as possible shoreline erosion control projects warranting further consideration. These plans, shown on Figures C5 and C6 following, are:

Plan 1 - Restored Sand Beach with Groin Field
Plan 2 - Restored Sand Beach with Offshore Breakwaters

Estimated Costs for Alternative Plans 1 and 2

Preliminary designs and quantity and cost estimates were prepared for these two structural plans. The estimated first cost and annual charges for each plan are shown in Table C2, below. From the tabulation it is seen that the first costs are $11.3 million and $5.2 million, and the annual charges would be $1.4 million and $0.7 million for Plans 1 and 2, respectively.

Table C2 - First Cost and Annual Charges for Plans 1 and 2,
East Harbor State Park Beach Erosion Project
(February 1980 Price Levels)

Item	Federal	Non-Federal	Total
	$	$	$
Plan 1 - Restored Beach with Groin Field			
First Cost	1,000,000	10,300,000	11,300,000
Annual Charges			
Capital Recovery Factor (0.07361)	74,000	758,000	832,000
Maintenance of Structures 1/	-	157,000	157,000
Sand Nourishment 2/	284,000	122,000	405,000
Total Annual Charges Plan 1	358,000	1,037,000	1,395,000
Plan 2 - Restored Beach with Breakwaters			
First Cost	1,000,000	4,160,000	5,160,000
Annual Charges			
Capital Recovery Factor (0.07361)	74,000	306,000	380,000
Maintenance of Structures 1/	-	56,000	56,000
Sand Nourishment 2/	170,000	73,000	243,000
Total Annual Charges Plan 2	244,000	435,000	679,000

Note: All figures have been rounded to the nearest $1,000. Annual charges are based on 50-year project life and 7-1/8 percent interest rate.
1/ 2% of construction costs of structures (excluding engineering and design).
2/ Estimated 10 percent of initial placement will be required annually. Federal cost-sharing will be renegotiated after 5 years.

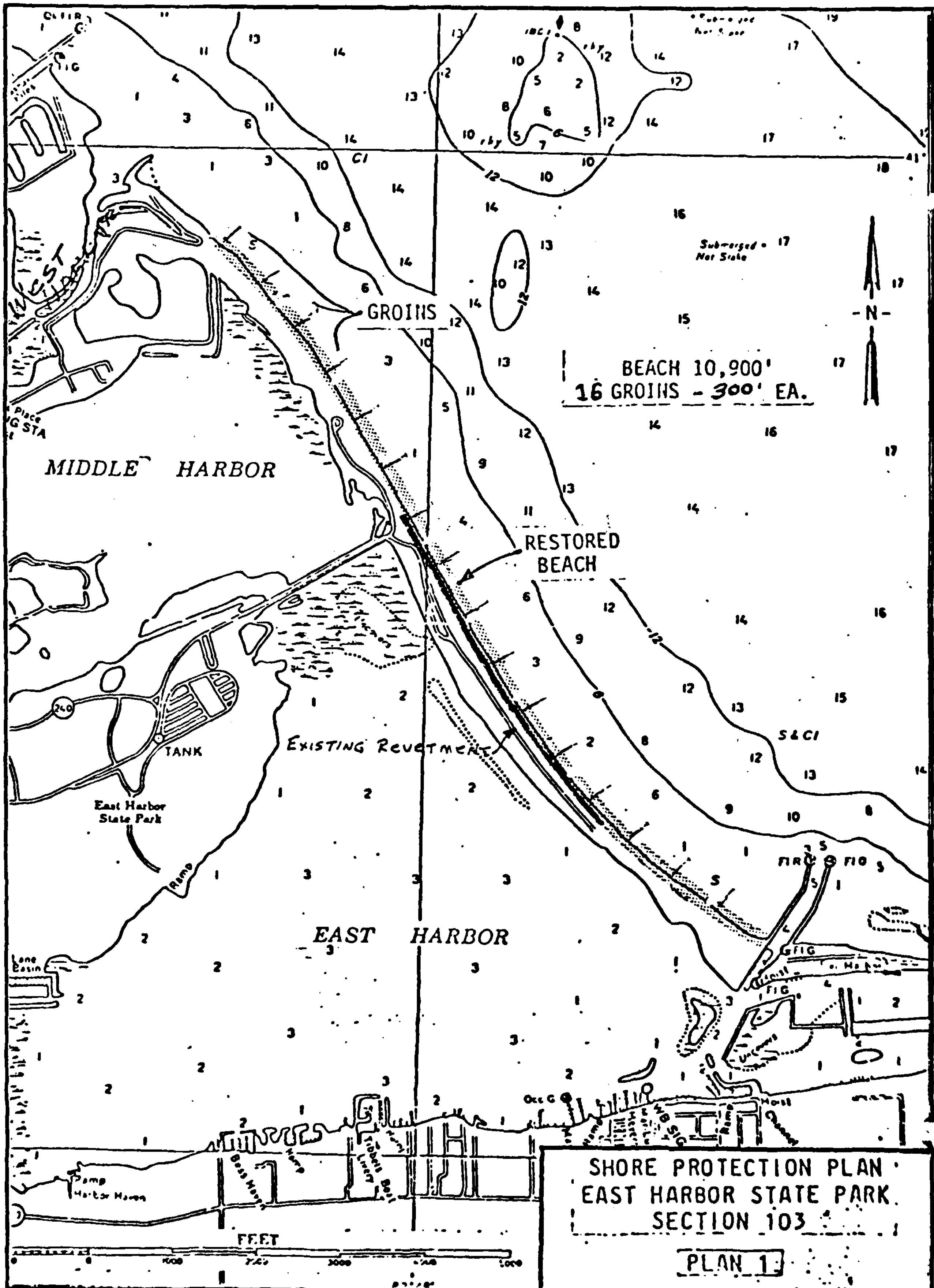
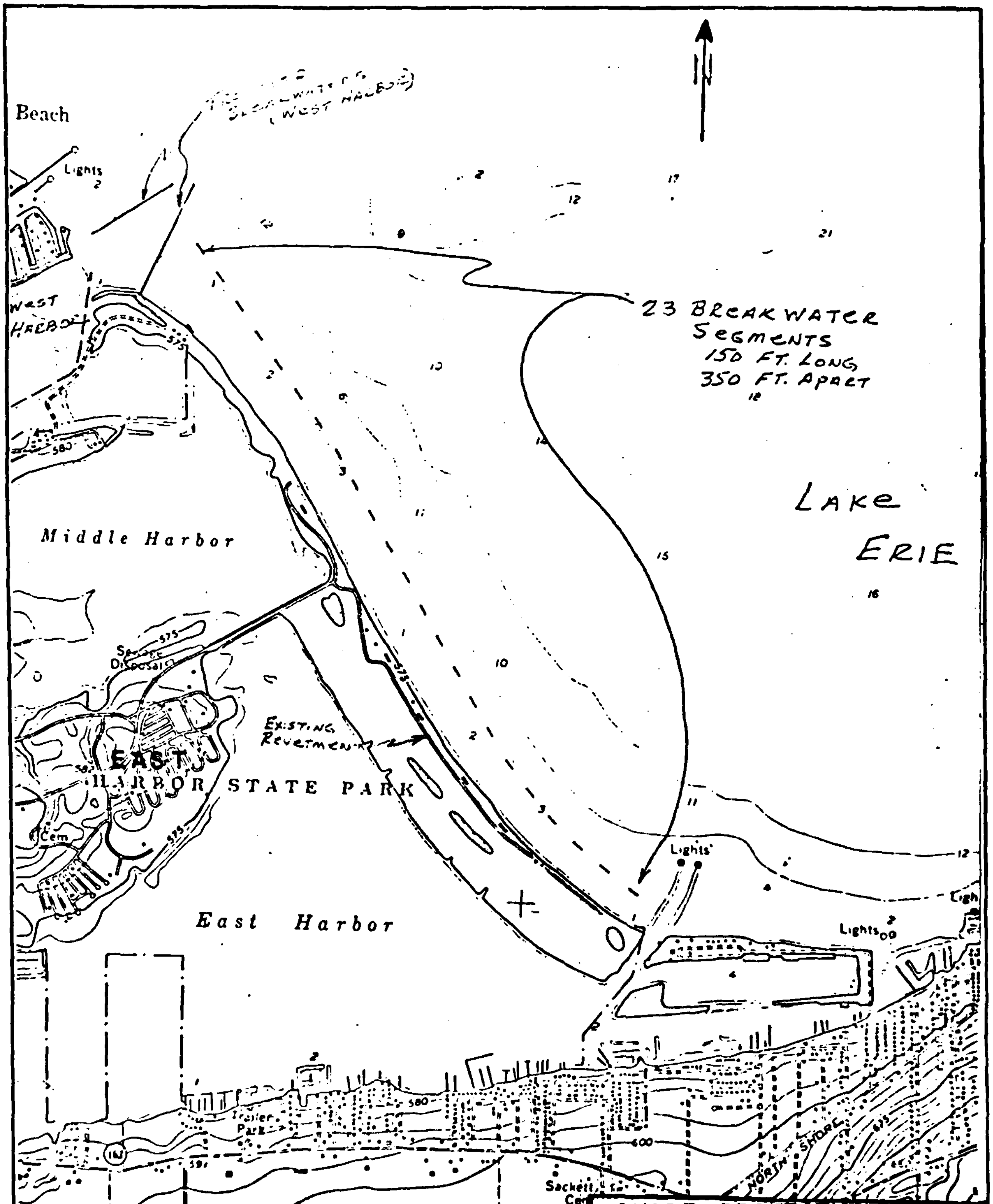

GROINS
BEACH 10,900'
16 GROINS - 300' EA.
-N-
MIDDLE HARBOR
RESTORED BEACH
TANK
East Harbor State Park
Existing Revetment
EAST HARBOR
FEET
SHORE PROTECTION PLAN
EAST HARBOR STATE PARK
SECTION 103
PLAN 1

FIGURE C5



SHORE PROTECTION PLAN
EAST HARBOR STATE PARK
SECTION 103

PLAN 2

FIGURE C 6

Project Benefits

The benefits categories for the proposed shore protection project are recreation beach benefits, land losses prevented, and maintenance costs avoided. The primary category is in recreational beach benefits, which for the proposed increase in beach area of about 450,000 square feet and the resulting increase in design capacity of about 6,000 bathers would produce an annual increase of about 670,000 visitations. Based on the estimated unit day value of $2.48/visitor, the resulting annual recreation beach benefit would be approximately $1.6 million. Maintenance costs avoided were estimated at $32,200 annually and erosion benefits were estimated at $2,400, providing a total annual benefit for both Plans 1 and 2 of about $1.64 million.

Economic Efficiency

Net benefits and the benefit-to-cost ratios for Plans 1 and 2 are shown in Table C3, below. From the tabulation, it is seen that both plans are economically justified, although Plan 2 is significantly more economically efficient with a B/C of 2.4.

Table C3 - Economic Comparison of Plans 1 and 2 for East Harbor State Park Beach and Shoreline Erosion Project

Alternative	Average Annual Benefits	Average Annual Cost	Net Benefits	Benefit-Cost Ratio
	$	$	$	
Plan 1 (Groins)	1,643,300	1,395,000	248,300	1.18
Plan 2 (Breakwaters)	1,643,300	679,000	964,300	2.42

Discussion of Alternative Plans

Based on investment costs and economic efficiency, it is concluded that Plan 2 is preferred. However, because of the preliminary nature of the designs, and quantity and cost estimates for the Reconnaissance Report, and the absence of any quantitative environmental data, it is concluded that both structural alternatives and the No-Action Plan should be carried into the initial iteration of alternatives in Stage 2.

Plans of Others

The Ohio Department of Natural Resources is expected to construct three offshore breakwaters at East Harbor State Park in the summer of 1981 as a pilot project. The performance of these breakwaters will be monitored by ODNR and should provide valuable design information for use in the Corps Stage 2 study scheduled for initiation in FY 83.

Further Action on Study of Erosion Problem at East Harbor State Park

Based on the results of the Section 103 Reconnaissance Study and higher authority's concurrence to perform further study under the Congressionally-authorized Western Lake Erie Shore Study, Stage 2 feasibility investigations will be performed under this stated authority.

CITY OF OREGON (Flooding)

This flood problem area is located in Maumee Bay just east of Toledo as shown on Figure B8. As previously noted in Section B, approximately 214 residential and 3 commercial units in this 3.1-mile reach of Lake Erie shoreline are susceptible to flood damages. Average annual flood damages are estimated at $30,600 (January 1981 price levels). Due to construction of shoreline protective works by private interests, shoreline erosion damage to private lands and structures is minor.

Alternative Plans Considered

Flooding at Oregon results from high lake levels and is aggravated by coincident wave action. Measures considered to solve the flooding problem were an armored clay dike along the shoreline, floodproofing, and evacuation. Evacuation was eliminated as a viable alternative after cursory consideration because the estimated cost for relocations would be over $5 million for 215 properties, resulting in a benefit-to-cost ratio less than 0.1. Two plans were identified as possible solutions to the flooding problem at Oregon. These plans were:

Plan 1 - Stone-Armored Clay Dike
Plan 2 - Nonstructural

In addition, the No-Action plan was designated as Plan 3. These plans are discussed below.

Plan 1 - Armored Dike

a. Description - For Plan 1, approximately 11,000 lineal feet of lakefront dike would be constructed between Wynn Road on the west and Norden Road on the east as shown in Figure C7, following. Although the total reach studied was about 3.1 miles, protection was limited to the 2.1 mile reach where flood damages are concentrated to minimize costs for the preliminary evaluation. For this first iteration, it was assumed that appurtenant works to accommodate interior drainage and interior dikes to prevent inundation from the flanks would not be required - again to minimize costs.

b. Design and Cost Estimates - Computations for the preliminary design of the dike structure are presented in Appendix C, and the quantity and cost estimates in Appendix D. The resulting typical dike section is shown on Figure C7. The dike would be located along the toe of the low bluff at elevation 570.0 IGLD. This location was selected because of the close proximity of some residential structures to the top of bluff. Armoring of the lakeward face of the dike would be required to provide protection against failure from

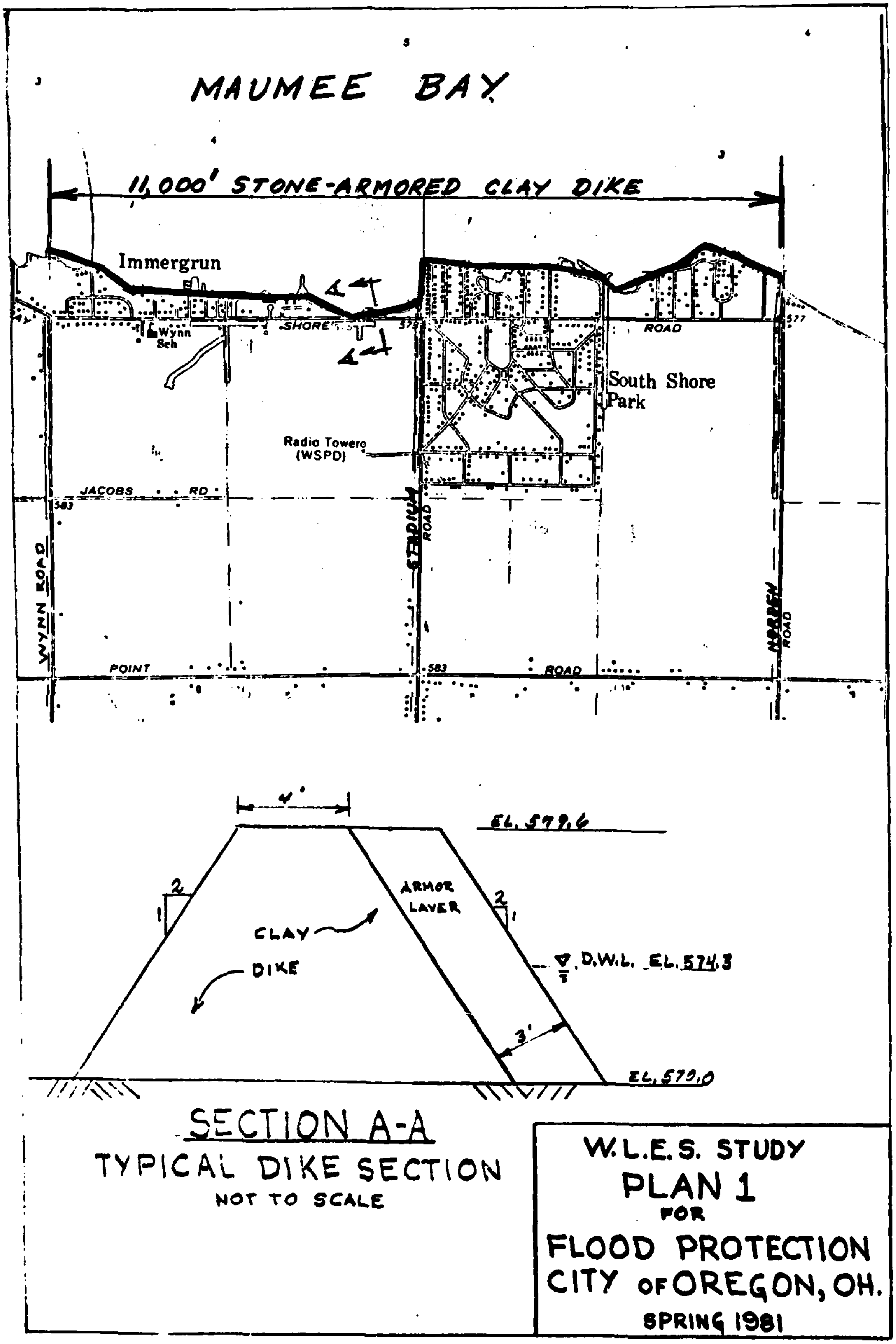

MAUMEE BAY
11,000' STONE-ARMORED CLAY DIKE
Immergrun
Wynn Sch
SHORE
ROAD
South Shore Park
Radio Towers (WSPD)
JACOBS RD
583
WYNN ROAD
STADIUM ROAD
NORDEN ROAD
POINT
ROAD
4'
EL. 579.6
2
1
ARMOR LAYER
CLAY DIKE
D.W.L. EL. 574.3
3'
EL. 570.0
SECTION A-A
TYPICAL DIKE SECTION
NOT TO SCALE
W.L.E.S. STUDY
PLAN 1
FOR
FLOOD PROTECTION
CITY OF OREGON, OH.
SPRING 1981

FIGURE C 7

wave action. The estimated construction cost of Plan 1 would be approximately $5.5 million, and annual charges (7-3/8 percent interest rate and 50-year project life), including annual maintenance, are estimated at $421,000 (see Table 11 of the Economics Appendix).

c. Benefits for Plan 1 - The benefit categories for Plan 1 are flood damages prevented and affluence. Existing regulations preclude inclusion of erosion benefits for shoreline areas in private ownership. Thus, no benefits have been taken at Oregon or other areas in private ownership for erosion damages prevented. No benefits were taken for future development as it is assumed that such development will be constructed above the 100-year flood level in conformance with the requirements of the Federal Flood Insurance Program. To maximize potential benefits for this preliminary evaluation, it was assumed that there are no residual flood damages under improved conditions. Based on this assumption, the benefits for Plan 1 would be:

Benefit Category	Average Annual Benefits
Flood Damage Reduction	$30,600
Affluence	3,600
Total Annual Benefits	$34,200

d. Economic Efficiency for Plan 1 - Based on the minimized average annual charges of $421,000 and maximized annual benefits of $34,200, the benefit-to-cost ratio for Plan 1 is 0.1, and net benefits are estimated at -$386,800.

Plan 2 - Nonstructural (Raise 1st Floor, Floodproofing)

a. Design Rationale - The 100-year Lake Erie level at Oregon is estimated at 576.4 IGLD, and including an estimated 2 feet of coincident wave runup, the design lake level is 578.4. For the damage analysis and nonstructural design, it was assumed that only those structures at the shoreline would be affected by the wave runup. Based on this assumption, the damage analysis showed that 69 homes would be affected by wave runup. Of these 69 homes, 40 would experience first floor flooding at the design water elevation of 578.4. These 40 homes would be raised to prevent first floor flooding. Nine of the remaining 29 dwellings have basements and would be floodproofed and the remaining 20 only sustain yard damage and cleanup. Of the remaining 147 homes that sustain damages at the static 100-year elevation of 576.4 (216 homes - 69 homes), 9 have first floor elevations below 576.4 and also would be raised. An additional 27 homes with basements would be floodproofed. This then leaves 111 homes that sustain only yard and cleanup damage. No nonstructural measures (with the exception of regrading or ring/levees around the properties) are available for preventing these types of damages, so these 111 homes would continue to sustain minimal damages and would not be

floodproofed. In summary, the nonstructural Plan 2 would consist of the following:

Nonstructural Measure		No. of Dwellings
Raise First Floor		49
Floodproof Basement		36
No Change		131
	Total	216

b. Cost Estimate for Plan 2 - The preliminary cost estimate for this nonstructural plan was based on average values for nonstructural measures presented in Physical and Economic Feasibility of Nonstructural Flood Plain Management Measures by the Hydrologic Engineering Center and Institute for Water Resources, dated March 1978. Based on these data, the construction cost for Plan 2 would be $660,000, determined as follows:

Nonstructural Measure	Number of Units	Unit Cost1/	Estimated Cost
Raise 1st Floor	49	$9,700	$475,000
Floodproof Basement	36	1,600	55,000
Subtotal			$530,000
Contingencies (25 Percent)			130,000
Construction Cost			$660,000

1/ January 1981 price levels.

Based on a 7-3/8 percent interest rate and a 50-year project life (probably liberal for this area, and more liberal than the 30-year period used in the HEC-IWR reference), the annual charges for Plan 2 would be about $50,000.

c. Economic Efficiency for Plan 2 - As previously stated, nonstructural improvements would not be provided for 131 of the 216 dwellings because these properties only sustain yard and cleanup damage for the 100-year event. Since over 60 percent of the residential properties would realize no flood damage reduction for Plan 2 (or any other nonstructural plan), residual average annual damages under improved conditions were evaluated for Oregon and were estimated to be $6,000, or about 20 percent of the average annual damages for existing conditions. Therefore, average annual flood damage reduction benefits for Plan 2 are $28,200 ($34,200 existing - $6,000 improved).

Further Study of Flooding at Oregon, OH

Economic comparison of the plans of improvement considered for reducing the flood problem at Oregon is as follows:

	Alternative Plan 1 (Dike)	Alternative Plan 2 (Nonstructural)
Project Construction Cost	$5,547,000	$660,000
Annual Charges 1/	421,000	50,000
Annual Benefits	34,200	28,200
Net Benefits	-386,800	-21,800
B/C Ratio	0.1	0.6

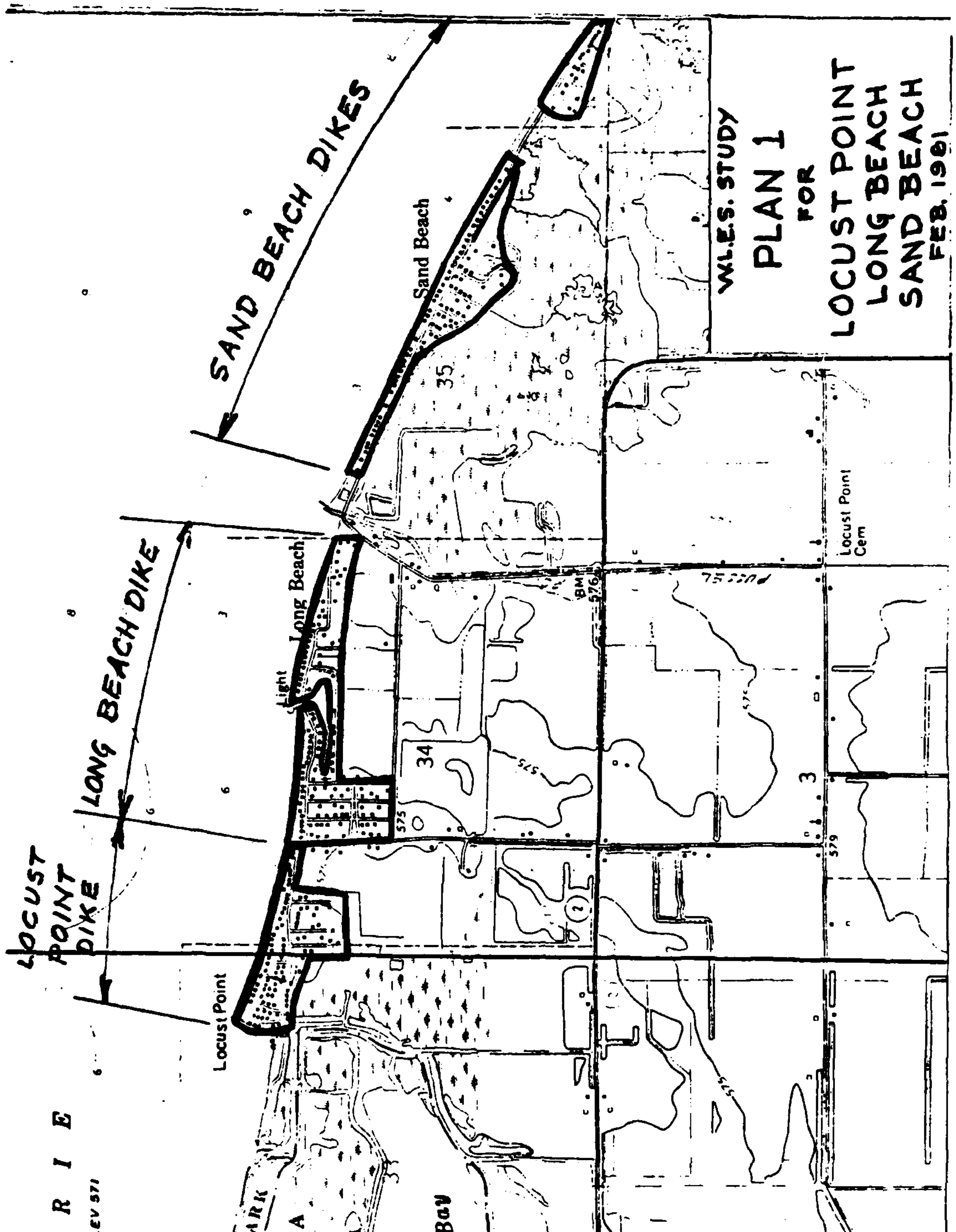
1/ 50-year project life and 7-3/8 percent interest rate.

From this tabulation, it is concluded that an economically justified plan of improvement to alleviate flooding at Oregon cannot be provided. Therefore, the No-Action Plan has been selected, and no further study of the flooding problem at Oregon will be made at this time.

LOCUST POINT, CARROLL TWP. (Flooding)

The Locust Point - Long Beach - Sand Beach area, as shown on Figure C8 following, is for all practical purposes one continuous development along approximately 13,000 feet of Lake Erie shoreline. Although all three developments experience similar flooding problems, the type, value, and location of individual dwellings in each of these areas are sufficiently different to warrant individual consideration with regards to possible economic feasibility. For this reason, each development was evaluated independently, while retaining the option of combining plans for each into a single plan if improvements for more than one of the three areas was found to be viable.

As previously noted in Section B, of the 131 dwellings in the Locust Point development, 96 would experience first floor flooding during an occurrence of the 100-year event on Lake Erie and the remaining 35 would sustain yard and cleanup damage. From the flood damage analysis (see Appendix A), average annual flood damages for existing conditions is $26,100. Assuming that there would be no residual flood damages for improved conditions (a liberal assumption particularly for nonstructural plans) and assuming about 10 percent for affluence, total annual benefits would be approximately $30,000. The cost of relocating the 96 residential units that are susceptible to first floor flooding out of the flood plain would be about $2.5 million. The annual charges for this evacuation plan would be approximately $190,000, resulting in a benefit-to-cost ratio of about 0.2. Therefore, evacuation was not considered to be a viable plan for Locust Point, and was dropped from further consideration. Consistent with the type of flood problem that exists at



LAKE ERIE
APPROXIMATE MEAN LAKE ELEV 571
SAND BEACH DIKES
LONG BEACH DIKE
LOCUST POINT DIKE
Sand Beach
Long Beach
Light
Locust Point
STATE PARK AREA
Turtle Creek Bay
Roadside Park
Locust Point Cem
BM 575
BM 576
34
35
3
W.L.E.S. STUDY
PLAN 1
FOR
LOCUST POINT
LONG BEACH
SAND BEACH
FEB. 1981

FIGURE C8

Locust Point and characteristics of the area, one structural plan and another nonstructural plan were considered. These plans are:

Plan 1 - Armored Dike
Plan 2 - Nonstructural (Raising First Floors)

Plan 1 - Armored Dike

a. Design Rationale - The conceptual layout for this plan is shown on Figure C8. Approximately 50 percent of the 2,500 feet of shoreline is occupied by dwellings too close to the shoreline to effectively construct the lakefront dike on top of the existing bluff. Therefore, 1,250 feet of the dike would be founded at the toe of the low bluff, or at about elevation 570.0. The remaining 1,250 feet of lakefront dike would be constructed on the low bluff. The crest elevation of the dike was set at elevation 579.0 IGLD. This dike would be armored with stone to prevent failure from wave attack. An interior earth dike would be required to prevent flooding from the south. This dike would have a crest elevation of 577.0 because it would not be affected by wave action and wave runup.

b. Cost for Plan 1 - The total cost of construction for the Locust Point dikes would be approximately $650,000 at January 1981 price levels. Based on a 50-year project life and 7-3/8 percent interest rate, annual charges (excluding operation and maintenance), would be $49,300.

c. Economic Efficiency of Plan 1 - With annual benefits of $30,000 and annual charges of $49,300, the benefit-to-cost ratio for Plan 1 is 0.6 and net benefits are - $19,300.

Plan 2 - Nonstructural (Raising First Floors)

a. Design Rationale - For this nonstructural plan, the first floors of the 96 residential units that would sustain first floor flooding during an occurrence of the 100-year flood event would be raised to prevent first floor flooding. Since none of the remaining 35 dwellings at Locust Point have basements, damage to these 35 units was assumed to be limited to yard and cleanup damage and is therefore nonpreventable for the nonstructural plan.

b. Cost Estimate and Annual Charges for Plan 2 - The cost to raise the first floor above the 100-year water level would be approximately $9,700 per unit. For the 96 units that would sustain first floor flooding, the first cost of Plan 2 would be approximately $930,000, and the annual charges (at 7-3/8 percent interest rate, and 50-year project life) would be approximately $70,000.

c. Economic Efficiency for Plan 2 - With annual benefits of $30,000 and annual charges of $70,000, the benefit-to-cost ratio would be about 0.4, and the net benefits would be -$40,000.

Further Study of Flooding at Locust Point, OH

Economic comparison of the plans of improvement considered for reducing the flooding problem at Locust Point is as follows:

	Alternative Plan 1 (Dike)	Alternative Plan 2 (Nonstructural)
Project Construction Cost	$650,000	$930,000
Annual Charges 1/	49,300	70,000
Annual Benefits	30,000	30,000
Net Benefits	-19,300	-40,000
B/C Ratio	0.6	0.4

1/ 50-year project life and 7-3/8 percent interest rate.

From this tabulation, it is concluded that an economically justified plan of improvement for alleviating flooding at Locust Point cannot be obtained. Therefore, the No-Action Plan has been selected, and no further study of flooding at Locust Point will be made at this time.

LONG BEACH, CARROLL TWP. (Flooding)

There are about 130 residential dwellings in this development that are susceptible to flooding from Lake Erie. These homes are valued from a minimum of approximately $25,000 to a maximum of over $100,000. Of the 130 dwellings, 52 would experience first floor flooding during the 100-year event (open-coast water surface elevation = 578.8 IGLD). The remaining 78 properties experience only yard and cleanup damages.

Average annual flood damages for Long Beach were estimated at $34,600 (January 1981 price levels), and including an additional 10 percent for affluence, the total average annual benefits would be approximately $38,000, assuming no residual damages for improved conditions. Because the cost of relocating the 52 affected dwellings would be approximately $2 million, it is obvious that evacuation would not be economically justified (benefit-to-cost ratio about 0.3) and was eliminated from further consideration. One structural plan and one nonstructural plan were considered for Long Beach. These plans are:

Plan 1 - Dike
Plan 2 - Nonstructural (Raise First Floor Elevation)

Plan 1 - Armored Dike

a. Design Rationale - The conceptual layout for Plan 1 is shown on Figure C8. As was discussed above for Locust Point, the dike would completely encircle the Long Beach development to prevent flooding from the flanks or the rear. Of the 4,000 feet of lakeward armored dike, approximately 3,000 feet would be constructed on top of the low bluff at elevation 575 and the remaining 1,000 feet at the toe of the bluff at elevation 570.

The crest of this dike would be at elevation 579.0. The interior 4,000-foot dike would be constructed of earth and have a crest elevation of 577.

b. Cost for Plan 1 - The estimated total construction cost would be $925,000 (January 1981 price levels). Based on a 7-3/8 percent interest rate and 50-year project life, the annual charges (excluding O&M) would be about $70,000.

c. Economic Efficiency for Plan 1 - Assuming that there are no residual flood damages, the annual benefits are estimated at $38,000. With annual charges of $70,000, the B/C ratio for Plan 1 is 0.5.

Plan 2 - Nonstructural (Raise 1st Floor Elevation)

a. Design Rationale - As previously stated, 52 of the 130 dwellings would experience first floor flooding during the 100-year event. To eliminate damages to the structures and contents, the first floor of all 52 structures would be elevated to elevation 579.0 or 577.0, dependent upon location. No improvements would be made to the remaining 78 properties because none have basements, so floodproofing of these residences would not be required.

b. Cost for and Economic Efficiency of Plan 2 - The estimated cost of raising the 52 homes, at $9,700 per structure, is about $504,000. Including 25 percent for E&D and S&A, the total cost of construction would be $630,000. Annual charges at 7-3/8 percent interest and 50-year project life are $48,000.

With annual benefits of $38,000 and annual charges of $48,000, the benefit-to-cost ratio of Plan 2 is 0.8.

Further Study of Flooding at Long Beach

Economic comparison of the plans of improvement considered for reducing the flooding problem at Long Beach are as follows:

	Alternative Plan 1 (Dike)	Alternative Plan 2 (Nonstructural)
Project Construction Cost	$925,000	$630,000
Annual Charges	70,000	48,000
Annual Benefits	38,000	38,000
Net Benefits	-32,000	-10,000
B/C Ratio	0.5	0.8

From this tabulation, it is obvious that Plan 1 cannot be economically justified, and is therefore eliminated from further consideration. Plan 2 - the nonstructural plan - with a B/C ratio of 0.8, nearly meets the economic standard of 0.9 established for further study. However, the B/C determination for Plan 2 assumed zero residual damages for the improved condition. Based on the analysis of residual flood damages performed for the Oregon flood problem area, it is reasonable to assume that residual flood damages

for Long Beach would be at least 25 percent of the existing annual damages, or say $8,000. Based on this assumption, the annual benefits would be reduced to $30,000, and the B/C ratio would be 0.6. On this basis, it is concluded that no further study should be made of the flooding problem at Long Beach at this time and the selected plan is No-Action.

SAND BEACH (Flooding)

Sand Beach is the easterly most of the three adjoining lakefront developments in Carroll Township. Based on a dwelling count performed by the Buffalo District damage survey crew in February 1981, there are 140 residential units at Sand Beach. These homes occupy a narrow strip of land along approximately 7,000 feet of Lake Erie shoreline. An estimated 100 of these units would sustain damage of some degree during an occurrence of the 100-year flood on Lake Erie, and approximately 40 would experience 1st floor flooding. These homes vary in value from about $20,000 to about $100,000 with most in the $30,000 to $40,000 range. None of these homes have basements. Average annual flood damages for Sand Beach are estimated at $28,600 (see Appendix A).

Alternative Plans Considered

Because of the limited flood damages sustained at Sand Beach ($28,600 annually), the long reach of shoreline (7,000 feet) involved, and the number of homes that would have first floor flooding (40 homes), and after comparison with the negative economic results for Locust Point and Long Beach, it was concluded that the results for Sand Beach would be the same. Therefore, only cursory consideration was given to possible flood control improvements at Sand Beach. As with the other developments, the measures considered were evacuation, construction of an armored dike (structural), and raising first floor elevations of the residences (nonstructural).

Evacuation was eliminated because of the estimated high cost (about $1.5 million) involved. The benefit-to-cost ratio for evacuation would be about 0.3.

The 7,000 feet of armored dike fronting Lake Erie and a similar length of earth dike along the rear of the development (to prevent flooding from the south) would have a total construction cost of about $1.7 million, and annual charges of approximately $126,000. The B/C ratio would be about 0.3.

The nonstructural alternative would consist of raising the first floor elevation of the 40 homes that would sustain first floor flooding during an occurrence of the 100-year flood. The cost of this work, at $9,700 per unit, would be about $485,000, including 25 percent for E&D and S&A. Annual charges for raising these 40 homes at 7-3/8 percent interest rate and 50-year project life are $36,800. Assuming that there are no residual flood damages and an estimated 10 percent of the annual damages for affluence, the annual benefits would be $31,500, providing a B/C ratio of 0.86, which is slightly less than the 0.90 standard used for this study. If it is assumed that residual flood damages would be 25 percent of the existing damages in the nonstructural plan (a reasonable assumption based on the analysis of residual

damages at Oregon for the nonstructural plan at that location), the annual benefits at Long Beach will be about $24,000 and the benefit-to-cost ration would then be about 0.7.

Further Study of Flooding at Sand Beach

Based on the preliminary analysis performed, it is concluded that an economically justified flood protection project cannot be obtained for the Sand Beach development, and that no further studies should be performed at this time. Therefore, the selected plan for Sand Beach is No-Action.

CITY OF PORT CLINTON (Flooding)

This flood problem area is located near the eastern end of the study reach as shown on Figure B8 of Section B. Approximately 5 miles of urbanly-developed Lake Erie shoreline is affected by flooding to some degree at Port Clinton.

As previously noted in Section B, and discussed in further detail in the Hydraulics and Economic Appendices, approximately 670 residential and 87 commercial units are affected, to some degree, by flooding. Of the 670 residential units, approximately 280 are mobile homes. Estimated average annual flood damages are approximately $172,000 (January 1980 price levels), consisting of about $94,000 residential, $74,000 commercial, and $4,000 public and other. Based on an analysis of shoreline erosion rates in this reach, it is concluded that shoreline erosion damages are insignificant.

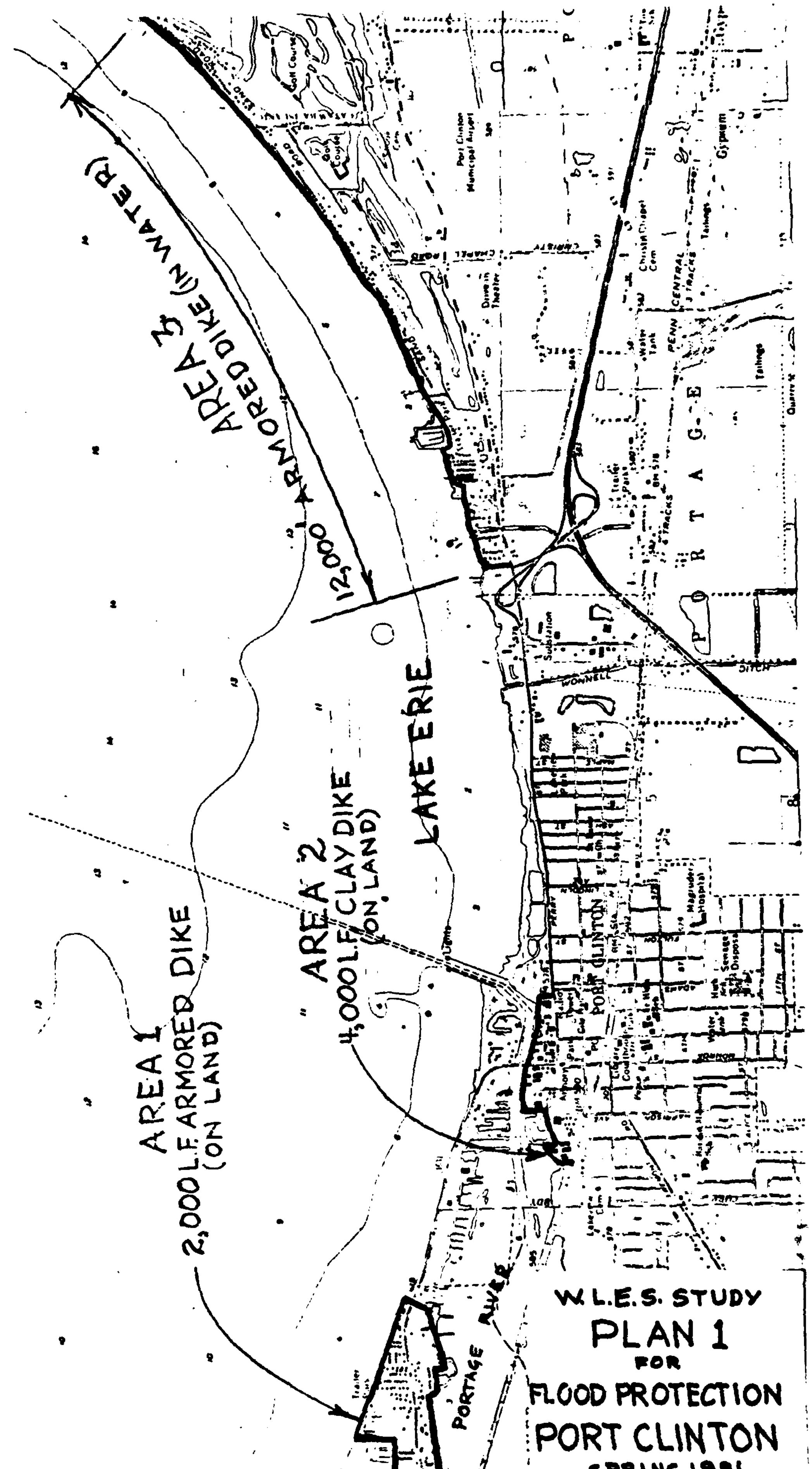
Alternative Plans Considered for Port Clinton

One structural plan and one nonstructural plan were considered as potentially viable for alleviating the flood problem in the Port Clinton area. These plans, discussed below, are:

Plan 1 - Dikes
Plan 2 - Nonstructural (Floodproofing, Evacuation, and Raising Structures)

Plan 1 - Dikes

a. Description - Flood damages were found to be concentrated in three discrete areas of the Port Clinton study reach. These three areas are identified on Figure C9, following, by the protective works that would be provided for Plan 1. Area 1, at the western end of this problem area, would be diked around its entire periphery to prevent inundation from both Lake Erie and the Portage River. It would be constructed on top of the existing bluff because it appears there is sufficient room to perform such construction without undue property acquisition, and because the existing bluff appears to be relatively stable. The lakeward portion of the dike would be armored with stone to prevent failure from wave attack. That portion fronting the Portage River would be constructed entirely of earth. Area 2, along the south bank of the Portage River in Port Clinton, is not subjected to wave attack and would be protected by a low earth dike tied into high ground at the railroad embankment on the west and Perry Street on the east. In Area 3, dwellings



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PORT CLINTON
SPRING 1981
FIGURE C9

are generally too close to the top of bluff to permit construction thereon. Therefore, the dike for Area 3 would be constructed at the toe of the bluff. The face of the dike for Area 3 would be armored to prevent failure due to wave attack. The dike would be tied into high ground at both ends. For this preliminary design, no provision was made for accommodating interior drainage.

b. Design and Cost Estimates - Design of the dikes for Areas 1 and 3 was based on the 200-year coincident condition of a 10-year wave combined with the 20-year design lake level. On this basis, the crest of the dikes was set at elevation 577.8 IGLD. See Appendix C for a discussion of the design and typical sections for the dikes.

Based on the preliminary quantity and cost estimate presented in Appendix D, the estimated construction cost for Plan 1 is approximately $5.1 million, and the annual charges (50-year project life and 7-3/8 percent interest rate) would be $389,000.

c. Economic Efficiency - The benefit categories for Port Clinton are flood damage reduction and affluence. As further discussed in the Economic Appendix, annual flood damage reduction benefits for Plan 1 are estimated at $171,800 (assumes no residual damages for Plan 1, which is liberal considering that only the three specific areas would be protected), and affluence benefits are estimated at $11,800 annual, for a total average annual benefit of $183,600.

With annual charges of $389,000 and annual benefits of $183,600, the benefit-to-cost ratio of Plan 1 would be about 0.5.

Plan 2 - Nonstructural (Floodproofing, Evacuation, and Elevating Structures)

a. Design Rationale - The nonstructural method selected was based on type of structure (i.e., mobile home, permanent dwelling with or without basement, type of commercial unit, etc.) and the presence or absence of first floor flooding for the 100-year event. Permanent residential dwellings with first floor flooding would be raised; permanent dwellings with basements that would not experience first floor flooding would be floodproofed, and those without basements would remain as is; mobile homes would either be relocated (evacuation) or elevated, depending on depth of flooding; and commercial and industrial units would be relocated or floodproofed, as appropriate. Output from the computer analysis of average annual residential damages was used to determine the number of residential units in each of

these categories, and information from the individual interviews was used for the commercial units. The nonstructural measures selected for Plan 2 are:

Nonstructural Measure	Number of Units	Unit Cost for Measure	First Cost
Raise 1st Floor			
Mobile Homes	103	$ 2,500	$ 257,500
Permanent Dwellings	115	9,700	1,115,500
Floodproof			
Permanent Dwellings	253	1,600	404,800
Commercial Buildings	87	10,000	870,000
Evacuation			
Mobile Homes	5	1,000	5,000
No Action			
Permanent Dwellings	14	-	-
Mobile Homes	173	-	-
Commercial Units	0	-	-
Totals	760	-	$2,652,800

b. Cost Estimate for Plan 2 - The estimated first cost for Plan 2 is approximately $2.65 million, as shown in the tabulation above. Including 25 percent for Engineering and Design and Supervision and Administration, the estimated total cost of construction for Plan 2 is about $3.3 million.

Based on a 50-year project life (liberal for mobile homes and residential units that are 10 to 25 years old, at present) and 7-3/8 percent interest rate, the annual charges (excluding O&M) for Plan 2 are $252,000.

e. Economic Efficiency for Plan 2 - For this preliminary analysis, it was assumed that there would be no residual flood damages for Plan 2. On this basis, average annual benefits would be the same as the average annual damages, or $183,600. With annual charges of $251,000, the benefit-to-cost ratio for Plan 2 is 0.7.

Further Study of Flooding at Port Clinton and Vicinity

Economic comparison of the plans of improvement considered for reducing the flooding problem at Port Clinton and vicinity is as follows:

	Alternative Plan 1 (Dikes)	Alternative Plan 2 (Nonstructural)
Project Construction Cost	$5,119,000	$3,315,000
Annual Charges[1/]	389,000	251,600
Annual Benefits	183,600	183,600
Net Benefits	-195,400	-68,000
B/C Ratio	0.5	0.7

1/ 50-year project life and 7-3/8 percent interest rate.

From this tabulation, it is concluded that an economically justified plan of improvement to alleviate flooding at Port Clinton and vicinity cannot be provided. Therefore, the No-Action Plan has been selected, and no further study will be made at this time.

SECTION D

ASSESSMENT AND EVALUATION OF PRELIMINARY PLANS

Completion of the iterative selection process is accomplished through the performance of the "Impact Assessment" and "Evaluation" tasks. These tasks are carried out initially for all alternatives which address one or more of the planning objectives. This process is then repeated in more detail in subsequent planning stages to again select the best of the remaining plans, with the ultimate objective being selection of the single best plan. One important result of each iteration is determining the type and depth of further studies required to continue the selection process. This result is of the utmost significance in Stage 1 because the primary purpose of formulating, assessing, and evaluating preliminary plans in this stage is to determine whether further study is warranted.

During Stage 1, an initial, but cursory, impact assessment was performed for those problem areas for which previous studies had not been performed. For problem areas in which previous studies have been performed - i.e., erosion at Maumee Bay State Park (Stage 2 Interim Report completed) and East Harbor State Park (Section 103 Reconnaissance Report completed) - summary results from these reports are referenced herein, as appropriate. The assessments performed for this Stage 1 are an early attempt to assess and evaluate the preliminary alternative plans introduced in the preceding section of this Stage 1 report. The objective at this point is to preliminarily identify potential impacts of the considered plans relative to basic and/or general, biological, social, and economic criteria.

ASSESSMENT CRITERIA

The following is a listing of the criteria against which the alternative measures are to be assessed. Criteria marked by an asterisk (*) are those specifically required by Section 122 of Public Law 91-611.

Social Criteria

Population Density
Population Mobility
Housing
*Displacement of People
Transportation
*Desirable Community Growth
*Aesthetic Values
Institutional Dynamics
Health & Safety
*Community Cohesion
*Noise
Leisure & Recreational Opportunities

Cultural and Biological Criteria

Archaeological Sites
Historical and Architecturally Significant Structures
Submerged Cultural Resources
Wetlands
Fisheries
Wildlife
Threatened or Endangered Species
Benthos
Littoral Zone
Vegetation
*Air Quality
*Water Quality
Nekton and Plankton
Terrestrial Soils and Bottom Substrate
Topography
Federal - State-Owned Natural Areas (Existing)
*Man-Made Resources
*Natural Resources

Other Environmental Criteria

Erosion
Sedimentation
Water Levels and Flows
Productivity

Economic Criteria

*Revenues
*Property Values
*Public Facilities
*Public Services
*Regional Growth
*Employment/Labor Force
*Business and Industrial Activity
*Displacement of Farms

RATIONALE FOR ASSESSMENTS PERFORMED IN STAGE 1

Excluding the erosion problem areas at Maumee Bay and East Harbor State Parks for which previous studies have been performed, the only other specific problem areas for which preliminary plans were generated are the flood problem areas at: City of Oregon; Locust Point, Long Beach, and Sand Beach all in Carroll Township; and the City of Port Clinton and vicinity. The following characteristics are common to all five areas:

- Affected development is confined to a relative narrow strip of land.

- The bluffline at each is presently highly disturbed by construction of erosion/flood protective works.

- The depth of flooding for the 100-year flood is generally between 2 and 4 feet, a short distance inland from the shoreline, and 3 to 5 feet in the immediate shore zone affected by wave action.

Because of these similarities in all five areas, the types of alternative measures with the greatest potential for solving the flood problems were found to be the same. These least-cost measures are armored and earth dikes, and nonstructural measures consisting of floodproofing, elevating dwellings, and evacuation. It then follows that the impacts of alternative actions on each area would be similar. Thus, the selective assessments discussed below are considered generally applicable to all five flood problem areas.

IMPACT ASSESSMENT OF STRUCTURAL (DIKE) PLANS

This structural measure (designated Plan 1 for all problem areas discussed in Section C) would be of similar design for each area, except for slight differences in crest elevation, the length of the dikes, and location of the dikes with respect to the bluffs along the shore. All dikes fronting on the lake would be armored with stone to prevent failure due to lake wave attack. Interior dikes, where required to prevent inundation from the rear, would be of earth construction, and would vary from about 2 to 4 feet in height. A cursory assessment of the pertinent social, environmental, and economic criteria follows.

Social Criteria

a. Population Density

- The dikes suggest long-term protection of a high degree and a sense of increased security, thereby inducing additional development. This would contribute to some increased population density, highly limited by the lack of undeveloped land within the contemplated line of protection.

b. Population Mobility

- Flood protection would allow for greater inward and outward population mobility. Those residents who wish to remain in the area could do so without continued losses. Those individuals who wish to leave the area would find their property easier to sell and there would be more potential buyers.

c. Housing

- If dikes are constructed, some limited expansion in residential development would take place.

d. Displacement of People

- The alignment of the dikes was selected to eliminate acquisition of dwellings, so little displacement is contemplated.

e. Transportation

- The presence of construction equipment would temporarily disrupt local traffic patterns.

- Flood control structures may conflict with existing or proposed shoreline transportation routes.

f. Desirable Community Growth

- Flood protection may induce limited lowland shoreline development. Whether this is desirable to those communities involved is yet to be determined.

g. Aesthetic Values

- Such construction would alter the existing shoreline setting. These relatively massive structures, 4 to 10 feet in height, may be considered aesthetically displeasing, and would obstruct the scenic view of Lake Erie.

h. Institutional Relationships

- Project development and maintenance would require interorganizational coordination and cooperation among the Corps of Engineers, the local cooperator (s), and other Federal, State, and local agencies with special interest and/or technical expertise.

- Project implementation may require local planning measures to regulate future development.

- Prior to installation of structures, purchase of properties and/or property easements would be required.

i. Health and Safety

- This plan would provide increased protection from flooding.

- The protective works may provide residents with a false sense of security from flooding.

- The dikes may provide increased habitat for rodents.

j. Community Cohesion

- Such protection could act as a community cohesive force.

k. Noise

- Temporary construction noise would occur during initial installation and maintenance.

1. Leisure and Recreational Opportunities

- These structures generally provide protection to lowland residential areas. No recreational areas would be affected.

- Dikes may alter or restrict access to use of the coastal zone in some cases; they could contribute toward restriction of some shoreline activities. In those areas where the dikes would be constructed partially in water, these structures may provide access points for use in recreational fishing.

Cultural Resources

a. Archeological Sites

- Sites in the construction zone and rights-of-way may be disturbed by the construction of dikes.

- Archeological sites within the area protected by the structures may be preserved.

b. Submerged Cultural Resources

- Construction of the in-water portions of the dikes could disturb or destroy submerged cultural resources.

c. Historical and Architecturally Significant Structures

- No structures listed in the National Register of Historic Places and all subsequent revisions are present in the project area.

Biological Criteria

a. Wetlands

- Wetlands along the interior dike alignment at Sand Beach could be altered or destroyed by excavation and/or filling during construction. No other wetlands would be directly affected.

- Construction of dikes near existing wetlands such as those at Locust Point and Sand Beach could alter existing drainage and circulation patterns that may destroy or disrupt the wetlands. Coordination with the U. S. Fish and Wildlife Service, which manages the Navarre Marsh Division of the Ottawa National Wildlife Refuge located southeast of Sand Beach, would be initiated should the proposed project require further study.

b. Fisheries

- No significant fisheres impacts are anticipated unless the dikes obstruct fish movement into an area normally used for spawning, feeding, or rearing of young. This could occur at the Sand Beach site.

c. Wildlife

- Existing productive habitat would be destroyed along the interior dike alignment at the Sand Beach site; revegetation would eventually occur on the earthen dike material of a different species composition and habitat type than that which would be destroyed.

- Along the shoreline of the various affected areas, permanent destruction would occur with the placement of armor stone. These sites are bluff bases or shoreline which, being naturally disturbed sites, are not significant in terms of wildlife production.

- Construction activities would disrupt and possibly temporarily displace local bird populations.

- Habitats and wildlife would be disrupted, displaced, or destroyed in borrow areas.

d. Threatened or Endangered Species

- Whether or not possible loss of critical habitat and/or disturbance to any rare or endangered fauna and flora would occur, would be investigated through coordination with Federal and State fish and wildlife agencies during subsequent planning stages, if the study is further authorized and funded by Congress.

e. Benthos

- Dike construction at the water/terrestrial shoreline interface may destroy or disrupt some existing invertebrates.

f. Littoral Zone

- In-water construction in the nearshore zone would destroy or alter some aquatic fauna-flora habitats.

g. Vegetation

- Placement of material to construct dikes would cover some existing terrestrial and/or wetland vegetation. Trees and shrubs along the alignment would be removed.

- New vegetation would need to be established on disturbed terrestrial soils.

They may be occupied by rare plant species characteristic of sites with substrate instability which have been recognized as being worthy of protection. Coordination with the National Heritage Program of the Ohio Department of Natural Resources would have to be carried out during subsequent planning stages, if the study is further authorized and funded by Congress.

h. Air Quality

- The presence of heavy construction equipment would cause some temporary, unavoidable adverse impacts on air quality during installation and maintenance.

i. Water Quality

- Short-term turbidity could occur during construction due to erosion of exposed soils. Accidental spillages of fuel, oil, grease, etc. could also occur during construction.

j. Nekton and Plankton

- No significant impact on plankton due to dike construction is anticipated. Construction and maintenance activity of dikes along the shallow aquatic/terrestrial shoreline interface could destroy or displace some minute plant-animal life in the water.

k. Terrestrial Soils and Bottom Substrate

- Dike construction and maintenance rights-of-way could possibly cover or alter prime and unique farmlands near the shoreline.

- Soils in the zone of construction activity would unavoidably receive increased compaction by heavy equipment. Compaction may contribute to permeability and drainage problems (e.g., shallow ponding) unless proper drainage is provided.

- Dike construction at the shoreline could disrupt or displace the bottom substrate.

l. Topography

- The existing land surface relief would be altered and land elevations at the lakefront dikes would be raised approximately 10 feet to elevation 579.6 IGLD (577.8 IGLD at Port Clinton), depending upon whether the dike is located at the top or the toe of existing clay bluffs. Where interior dikes are required (Locust Point, Long Beach, Sand Beach, and Port Clinton), elevations would be raised 2 to 4 feet to elevation 577.0 IGLD.

m. Federal/State Fish and Wildlife Areas

- Coordination with fish and wildlife agencies would be required to avoid conflict with existing or proposed management plans.

n. Man-Made Resources

- No man-made resources of natural character (wetlands, parks, etc.) exist in the project area.

o. Natural Resources

- Impacts to specific natural resource criteria (wetlands, fisheries, etc.) are discussed above.

Other Environmental Criteria

a. Erosion

- Increased protection provided to develop any undeveloped areas along the shore would decrease flooding frequency and thereby decrease the rate of soil erosion from surface runoff.

- Wind or rainfall runoff erosion may temporarily occur on exposed disturbed soils in the zone of construction, until new seeding on such areas becomes established to provide cover.

b. Sedimentation

- No significant impact with regard to sedimentation from installation of the dikes is anticipated, however, some windblown or runoff sedimentation may occur during construction.

c. Water Levels and Flows

- No significant impact on water levels would occur.

- Installation of dikes would shift the direction of existing surface runoff flows.

d. Productivity

- In addition to the destruction of productive habitat at the Sand Beach site, some adverse impacts on actively nesting terrestrial wildlife could occur in the immediate vicinity of construction.

- Similarly, construction activities may disrupt spawning activities of local fish species.

- Some potentially productive soil acreage (i.e., prime and unique farmland), could be adversely impacted, either directly or indirectly by the installation of dikes. Directly, fill material needed to build the dikes could cover productive soils resulting in an irreversible loss of potential cropland. Indirectly, dikes may alter surface drainage patterns that could cause or shift surface ponding to existing nearby croplands, or restrict farming equipment from entering fields until they drain. The potential loss of prime and unique farmlands would be investigated through coordination with the U. S. Soil Conservation Service during subsequent planning stages, if the study is further authorized and funded by Congress.

Economic Criteria

a. National Economic Development

- The benefits to the national output accrue due to the reduction in flood damages. Dikes provide flood control and reduce physical damages to buildings, reduce income losses sustained due to the flooding, and reduce flood emergency costs such as disaster relief.

- Preliminary cost estimates indicate the construction of dikes in any of the areas considered would not produce a net benefit (average annual benefits - average annual costs).

- Benefits to underemployed or unemployed labor forces would occur during the construction period.

b. Local Government Finance

Taxes - The response of the tax base to the installation of dikes will depend on the induced development and the extent of development.

Property Values - Dikes protect property against flooding and result in higher property values. The growth in metopolitan property values exceeds the growth in rural land values. Therefore, property value increases could be anticipated to be the greatest for those protected areas in the cities of Port Clinton and Oregon and slightly less for the more rural Locust Point-Long Beach-Sand Beach area.

Public Facilities - The dikes could provide protection to water resource facilities in the protected communities. Electricity, gas, water and sewerage, and transportation are included. The protection of roads and transportation facilities along the shoreline could encourage further development since they are important features for an area's development.

Public Services - If further development can be anticipated with increased flood protection, then the demand for public services can also be expected to increase. These services include education, health, social, police, and fire protection and utilities.

c. Regional Economic Development

Real Income Distribution - The potential expansion of commercial activities in the protected communities would expand the income sources for the local community. The new and expanded businesses would provide wages to the local populace. Project construction could provide benefits to those who are unemployed or underemployed.

Employment/Labor Force - Expansion of local commercial activities could result in reducing local unemployment or attracting new people to the community. The increase in local employment would result in subsequent increases in local personnel per capita incomes.

- Flood protection would reduce the number of emergency closure days to businesses, reducing losses sustained by employees who miss work.

Business/Industrial Activity - Flood protection may encourage business activities located mainly in Port Clinton to expand slightly. The reduction in physical damages to structures and reduced income loss would lower the risks of operation in floodprone areas. Future losses would also be reduced as inventories receive additional protection.

Displacement of Farms - No farms would be displaced as a consequence of dike construction.

IMPACT ASSESSMENT OF NONSTRUCTURAL PLANS

This nonstructural measure (designated Plan 2 for all problem areas discussed in Section C), would be of similar design for each area. Homes with first floors located below the 100-year flood level would be raised to prevent flooding. Homes with basements would be floodproofed using glass blocks and drains with one-way valves. A cursory assessment of the pertinent social, environmental, and economic criteria follows.

Social Criteria

a. Population Density

- These measures utilize protection of existing individual structures to reduce flood damages. In effect, the plan encourages the maintenance of present population densities in those areas protected. Floodproofing for future structures would have to be individually initiated or required through building codes. It generally increases construction costs and is usually required to obtain flood insurance. So, depending upon community interest and values towards developing in the flood plain, population and new structure density could either increase or decrease.

b. Population Mobility

- Those individuals who desire to remain in the floodprone areas but are unwilling to suffer future damages would be able to remain in their protected homes, thereby decreasing inward mobility. Floodproofed homes would be easier to sell, thereby increasing both outward and inward mobility.

c. Housing

- Increased expense to floodproof future structures could impact on housing opportunities in the flood plain.

- These measures would provide protection only to those structures which have experienced flood damages in the past.

d. Displacement of People

- Five mobile homes would have to be relocated in the Port Clinton area.

e. Transportation

- Floodproofing would not protect transportation routes during periods of flooding.

f. Desirable Community Growth

- Generally, floodproofing does not provide complete flood protection to structures, contents, and residents. Storms of higher intensity (above design flood frequency) could still cause problems; flooding of lower magnitude would still create siltation and scouring problems in unprotected areas of the flood plain. This could tend to reduce the rate of community growth.

- Floodproofing could tend to restrict types of development, since expense to floodproof large structures may be unacceptably too high to some people.

- Depending on community goals and values, rate of development could be restricted or promoted if floodproofing measures are adopted.

g. Aesthetic Values

- Floodproofing measures may degrade the aesthetic quality of some homes.

h. Institutional Relationships

- Project implementation would require interorganizational coordination and cooperation among the Corps of Engineers, the local cooperator (s), and other Federal, State, and local agencies with special interest and/or technical expertise.

- Project implementation may require local planning measures (zoning, building codes, etc.) to regulate future development in the flood plain.

- Prior to floodproofing, property easements would be required.

i. Health and Safety

- Floodproofing would provide a limited degree of protection in the flood plain.

- A false sense of security may subject existing and potential future increased population to flooding hazards.

- Although structures in the flood plain would be protected, there could still be drainage problems in unprotected areas of the flood plain, and perhaps potential flood-related sewage problems. Flooding of streets and roads may hinder fire and police protection.

j. Community Cohesion

- Improvements to some structures for flood protection and none for others may serve as a divisive force in those communities affected.

k. Noise

- Unavoidable construction noise would occur during floodproofing installation.

l. Leisure and Recreational Opportunities

- No significant impacts on leisure and recreational opportuntiies are anticipated.

Cultural Resources

a. Archeological Sites

- Since floodproofing consists of adjustments to existing structures, no earth excavation is anticipated.

b. Historical and Architecturally Significant Structures

- No structures listed in the National Register of Historic Places and all subsequent revisions are present in the project area.

- Floodproofing of potentially significant buildings may introduce architecturally incompatible components that alter the existing historic integrity of a structure.

c. Submerged Cultural Resources

- No impact on submerged cultural resources would be anticipated.

Biological Criteria

a. Wetlands; b. Fisheries; c. Wildlife; d. Threatened or Endangered Species; e. Benthos; f. Littoral Zone; g. Vegetation.

- Generally, no significant impacts on these resources are anticipated if floodproofing adjustments and raising of structures are implemented.

- Temporary noise and human activity associated with floodproofing measures may cause some species to avoid nearby habitats until such activity is terminated.

h. Air Quality

- Minor, short-term degradation would occur due to the presence of construction equipment during exterior floodproofing and raising of structures.

i. Water Quality; j. Nekton and Plankton; k. Terrestrial Soils and Bottom Substrate; l. Topography.

- No significant impacts on these resources are anticipated if floodproofing and the raising of structures are implemented.

m. Federal/State-Owned Natural Areas

- No significant impacts on existing Federal/State-owned natural areas are anticipated. Coordination with Federal and State natural resource agencies would be maintained to avoid conflicts with existing or potential management plans.

n. Man-Made Resources

- No man-made resources of natural character (wetlands, parks, etc.) exist in the project area.

o. Natural Resources

- Impacts to specific natural resource criteria (wetlands, fisheries, etc.) are discussed above.

Other Environmental Criteria

a. Erosion; b. Sedimentation; c. Water Levels and Flows; and d. Productivity.

- Generally, if floodproofing and raising structures are implemented, no significant impacts with regard to the above criteria would be anticipated. If these adjustments occur during the wildlife breeding season, associated noise could temporarily disturb nesting wildlife near such buildings, thereby affecting local productivity.

Economic Criteria

a. National Economic Development

- Elevation of structures and floodproofing would reduce potential damages to existing structures. All flood damage reduction to buildings, contents, and public facilities are a direct benefit to national output. However, preliminary cost estimates indicate that implementation of floodproofing measures in any of the areas considered would not produce a net benefit (average annual benefits - average annual costs).

b. Local Government Finance

Property Values - Flood protection for individual structures can be expected to enhance the property values of those structures.

Taxes - Tax revenues can be expected to increase slightly in response to increases in assessed property values.

Public Facilities - Sanitary sewerage backup during floods would be prevented by installation of one-way valves in floor drains in those homes requiring protection.

Public Services - Although individual structures would be protected, certain public services (police, fire, etc.) would have limited access due to the continued flooding of the local transportation network.

c. Regional Economic Development

Real Income Distribution - The reduction in flood damages due to floodproofing measures could slightly raise the regional income as it reduces the income losses sustained during flooding. Protection by floodproofing would preserve the contents of residential homeowners and inventories of local business concerns.

Employment/Labor Force - Floodproofing could reduce the number of emergency closure days due to flooding. The losses sustained by employees is a direct loss to the regional economy.

Business/Industrial Activity - The prevention of damages to commercial sales inventory is a direct benefit of floodproofing.

Displacement of Farms - No farms would be displaced.

EVALUATION

In the absence of significant beneficial environmental impacts that could be realized by construction of appropriate measures, the governing criterion for further study or ultimate project implementation is economic feasibility.

The cursory Stage 1 assessments undertaken for the five flood problem areas indicate that there are no significant beneficial environmental impacts for the structural and nonstructural measures considered. This conclusion was reached based on the following rationale:

- All five flood problem areas occupy long, narrow strips of Lake Erie shoreline. Measures considered for flood damage reduction should occupy about the same area, and do. These confined areas are presently relatively densely developed, and therefore preclude development of environmentally enhanced lands thereon unless residents are relocated. However, relocation (*evacuation*) is not a viable alternative for economic and social reasons. Thus, there is little or no, opportunity for environmental enhancement of these areas. More probably, the dike plans would require mitigation of loss of productive wetlands and other adverse effects.

There are no apparent nonquantitative overriding social or institutional factors. Therefore, economic feasibility is used as the sole criterion for establishing criterion for establishing justification for further study of these five flood problem areas. The economic comparison of the alternative plans considered as possible solutions to the flooding problem in these five areas is summarized in Table D1. From this tabulation, it is seen that none of the plans meet the standard economic efficiency criteria of positive net benefits or benefit-to-cost ratio greater than 1.0. It is therefore concluded that no further study of flooding should be undertaken for these five areas at this time.

EVALUATION OF SHORELINE AND BEACH EROSION PROBLEM AREAS

The results of concurrent studies on shoreline and beach erosion problems at Maumee Bay State Park and East Harbor State Park were presented in Section C of this report. In the interest of brevity and because approval has been provided by higher headquarters to perform Stage 3 studies for Maumee Bay State Park and Stage 2 studies for East Harbor State Park, the impact assessments and evaluations for these two problem areas are not duplicated herein. Reference should be made to the appropriate reports if additional information is desired.

Table D1 - Economic Comparison of Alternative Plans of Improvement Considered for the Five Flood Problem Areas Within the West Shore Lake Erie Study Area

	Problem Area/Alternative Plan									
	City of Oregon		Locust Point		Long Beach		Sand Beach		Port Clinton	
	Plan 1 Dike	Plan 2 Nonstructural	Plan 1 Dike	Plan 2 Nonstructural	Plan 1 Dike	Plan 2 Nonstructural	Plan 1 Dike	Plan 2 Nonstructural	Plan 1 Dike	Plan 2 Nonstructural
	$	$	$	$	$	$	$	$	$	$
Total Construction Cost	5,547,000	660,000	650,000	930,000	925,000	630,000	1,700,000	485,000	5,119,000	3,315,000
Annual Charges	421,000	50,000	49,300	70,000	70,000	48,000	126,000	36,800	389,000	251,000
Annual Benefits	34,200	28,200	30,000	30,000	38,000	38,000	31,500	31,500	183,600	183,600
Net Benefits	-386,800	-21,800	-19,300	-40,000	-32,000	-10,000	-94,500	-5,300	-195,400	-68,000
B/C Ratio	0.1	0.5	0.6	0.4	0.5	0.8	0.3	0.86	0.5	0.7

SECTION E
STUDY MANAGEMENT

The purpose of this section is to present information on the remaining study activities that must be performed to fully respond to the Congressional resolution authorizing the Western Lake Erie Shore (WLES) feasibility study. The conclusions reached regarding further study activities are based on the results obtained through performance of the Stage 1 tasks of problem identification, formulation of alternatives, impact assessment, and evaluation.

Based on the evaluation presented at the end of Section D, it is concluded that, for the 60-mile reach of the Lake Erie shoreline covered by the Western Lake Erie Shore Study, no further study of flooding should be made at this time. Conversely, it is concluded that further study of the shoreline and beach erosion at Maumee Bay State Park and East Harbor State Park is in the Federal interest and appropriate. Thus, the remaining discussion in this section pertains to contemplated study activities that will be performed for Maumee Bay and East Harbor State Parks.

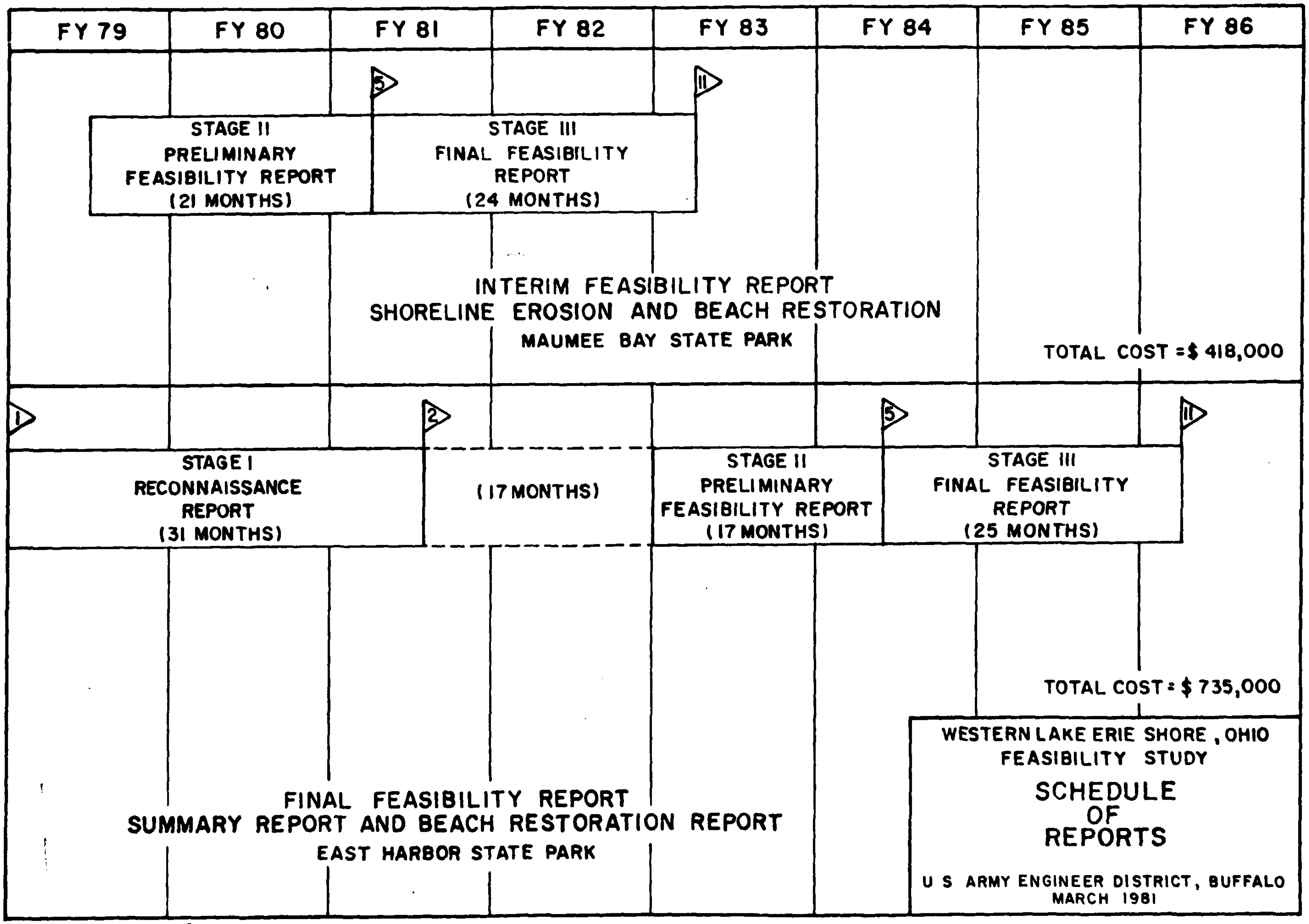
FUTURE REPORTS AND SUMMARY SCHEDULES

Two separate feasibility reports will be prepared under the Western Lake Erie Shore Study. These reports are: an Interim Report, currently underway, for Maumee Bay State Park; and a Final Report that will include a Summary Report on all study activities under WLES and a separate volume pertaining to the East Harbor State Park Beach Erosion Study. Stage 2 for the Maumee Bay Interim has been completed, and the Interim Final Feasibility Report is scheduled to be completed in the 2nd Quarter of Fiscal Year 1983. Stage 2 of the FinalReport (including the feasibility study for East Harbor State Park), will be initiated in Fiscal Year 1983 because of funding constraints, and Stage 3 is scheduled for completion in the 1st Quarter of Fiscal Year 1986. A schematic showing these report schedules is provided in Figure E1, following.

INTERDISCIPLINARY STUDY APPROACH

Requirements of P&S, NEPA, and others, demonstrate the need for an interdisciplinary team approach in investigating programs for managing and developing the nation's water resources. Such an approach has been used during this Stage 1 effort and will continue to be used during subsequent stages of this study.

The interdisciplinary approach is most effective when a diversity of professional skills is used. During Stage 1, the District's interdisciplinary planning team included a study manager, a coastal engineer, a coastal geologist, an economist, an hydraulic engineer, a soils engineer, an aquatic biologist, a sociologist, a civil engineer, and several civil engineering



FY 79
FY 80
FY 81
FY 82
FY 83
FY 84
FY 85
FY 86
5
11
STAGE II
PRELIMINARY
FEASIBILITY REPORT
(21 MONTHS)
STAGE III
FINAL FEASIBILITY
REPORT
(24 MONTHS)
INTERIM FEASIBILITY REPORT
SHORELINE EROSION AND BEACH RESTORATION
MAUMEE BAY STATE PARK
TOTAL COST = $ 418,000
1
2
5
11
STAGE I
RECONNAISSANCE
REPORT
(31 MONTHS)
(17 MONTHS)
STAGE II
PRELIMINARY
FEASIBILITY REPORT
(17 MONTHS)
STAGE III
FINAL FEASIBILITY
REPORT
(25 MONTHS)
TOTAL COST = $ 735,000
FINAL FEASIBILITY REPORT
SUMMARY REPORT AND BEACH RESTORATION REPORT
EAST HARBOR STATE PARK
WESTERN LAKE ERIE SHORE, OHIO
FEASIBILITY STUDY
SCHEDULE
OF
REPORTS
U S ARMY ENGINEER DISTRICT, BUFFALO
MARCH 1981

FIGURE E1

technicians. The Corps effort was augmented by input from the U. S. Fish and Wildlife Service and considerable input from the County Engineers of Lucas and Ottawa Counties, Ohio, in addition to input from the professional staff of the Ohio Department of Natural Resources.

STAGE 3 STUDIES FOR MAUMEE BAY INTERIM REPORT ON SHORELINE EROSION

Reference should be made to Section F, "Study Management," of the Maumee Bay State Park, Ohio, Shoreline Erosion, and Beach Restoration Study Preliminary Feasibility Report, by Buffalo District (September 1980), for a detailed discussion of the Stage 3 activities for the Maumee Bay Interim. From that report, the technical studies that will be undertaken in Stage 3 are refinements of the Stage 2 investigations on coastal processes, design of protective works and associated quantity and cost estimates, recreational demand analysis, project benefits, and plan formulation. In addition, a subsurface exploration will be undertaken and an Environmental Impact Statement will be prepared. Stage 3 for the Maumee Bay State Park Interim Feasibility Report was initiated in the 2nd Quarter of Fiscal Year 1981, and is scheduled to be completed in December 1982. The Study Flow Network (CPM) of Stage 3 activities for the Maumee Bay Interim Report is included as Exhibit J1 of Appendix J.

STUDIES FOR THE FINAL REPORT (Emphasizes Beach Erosion at East Harbor State Park)

As previously noted, the principal activities involved in completing the Final Report are: (1) preparation of a Summary Report documenting the results of all studies undertaken for the Western Lake Erie Shore Study; and (2) Stage 2 and Stage 3 studies of the erosion problem at East Harbor State Park. The following emphasizes the studies for East Harbor State Park.

TECHNICAL STUDIES REQUIRED FOR STAGE 2 OF THE FINAL REPORT

Although a broad range of alternative plans for solving the beach erosion problem at East Harbor State Park will be given initial consideration in Stage 2, it is expected that the study will quickly focus on further development of the offshore breakwater and groin plans formulated in the Section 103 Reconnaissance Report. There are several reasons for reaching this conclusion regarding the future study direction. First, the predominant water resources problem at East Harbor is loss of recreational beach. The only practical solution to this problem is beach restoration, which will require some type of structural protection for stability since the shoreline is subjected to significant wave attack and offshore and longshore losses. The groins or a breakwater system (more likely) are the logical measures for providing such protection. The purpose of Stage 2 is to evaluate the alternative plans in sufficient detail to decide which plans, if any, warrant more detailed study in Stage 3. Technical studies are required to formulate plans - and to a lesser degree to perform the remaining three planning tasks. These technical studies that will be performed in Stage 2 are discussed below. The Study Flow Network (CPM) showing the primary Stage 2 and Stage 3 activities for the East Harbor State Park beach erosion study is included as

Exhibit 2 in Appendix J. The Stage 3 technical studies, if required, will consist of further refinement of those performed in Stage 2.

Engineering Studies for East Harbor State Park in Stage 2 of the Final Report

a. Field Surveys - Bathometric and topographic surveys of nearshore and shoreline zone will be required. This work is expected to involve 3 man-months of effort.

b. Coastal Processes - Littoral Environmental Observation (LEO) stations will be established at East Harbor State Park early in Stage 2. The purpose of the LEO stations is to obtain site specific field data on wave direction, height and period, and littoral current characteristics. Theoretical wave analyses will be performed to establish wave design criteria for use in designing the shore protection works. An estimate of the loss in historical beach will be obtained. This activity is estimated to involve 1-1/2 man-months of effort, excluding report appendix preparation.

c. Preliminary Designs - As stated previously, it is assumed that preliminary engineering designs will be required for the groin and offshore breakwater plans. Design activities include determining the configuration of the restored beach section for each plan of improvement, typical design sections for the groins and breakwaters, and an estimate of the annual nourishment requirements for each alternative plan. This effort is expected to require 1 man-month, excluding report preparation.

d. Preliminary Quantity and Cost Estimates - Quantity and cost estimates will be obtained for the alternative plans of improvement. Approximately 1 man-month of effort is required for this task.

Stage 2 Economic Studies for East Harbor State Park

a. Recreational Demand Analysis - A site-specific recreation demand analysis will be performed. The demand for such activities as swimming and sunbathing, camping, hiking, and biking, including the interdependence of other recreation activities with swimming, will be required. An estimated 2-1/2 man-months will be needed for this task.

b. Benefit Analysis and Economic Efficiency - Average annual recreation benefits - based on consideration of the recreational need determined from the demand analysis and the design capacities for the various recreation uses to be provided at the park - will be obtained. This task will require 1 man-month of effort.

Stage 2 Environmental Studies for East Harbor State Park

a. Cultural Resources Survey - A cultural inventory of the site will be conducted. Although it is unlikely that significant submerged cultural resources exist on the site because the project area is presently highly disturbed, appropriate onsite investigations will be undertaken if the inventory so indicates. The initial effort will require 1 man-week.

b. Fish and Wildlife Coordination - A literature search, supplemented by appropriate field studies to obtain needed baseline data on benthic invertebrates, fish, and mammals will be performed by the USF&WLS through an Interagency Agreement with the Buffalo District. A draft Coordination Act report will be prepared addressing the potential impacts of considered alternatives on the fish and wildlife resources. The cost of this task is estimated at $6,000 for Stage 2.

c. Impact Assessment - An assessment of the probable social, cultural, biological, and resource impacts for the considered plans will be undertaken for Stage 2. An estimated 2 man-months of effort will be required.

Coordination During Stage 2

Close coordination will be maintained with the principal study participants, including the Ohio Department of Natural Resources and USF&WLS. Workshops will be scheduled with these agencies at about the time Stage 2 is initiated, and late in Stage 2.

Study Management During Stage 2

It is estimated that the study manager will invest between 40 and 50 percent of his time involved in study management. This includes coordination with and monitoring of the interdisciplinary team progress, preparation of schedule and budget data, and coordination and public involvement.

Preparation of Stage 2 Report for East Harbor State Park

Appropriate technical appendices will be prepared by members of the District's interdisciplinary team, and the study manager will prepare the text of the Stage 2 main report supplemented by input from the interdisciplinary team, as appropriate.

STAGE 3 STUDIES FOR THE FINAL REPORT (Emphasis on Erosion Problem at East Harbor State Park)

If the results of Stage 2 indicate that Stage 3 should be undertaken, more detailed studies will be performed. These studies would focus on that plan, or plans, found to warrant more detailed study through appropriate iteration of the four planning tasks in Stage 2. From the schedules shown in Figure E1 earlier, it is seen that Stage 3 work for the Final Report is presently scheduled to start in the 2nd Quarter of Fiscal Year 1984, and will take about 2 years, or until 1st Quarter of FY 1986 to complete.

As stated above, the technical studies in Stage 3 would provide further refinement of the designs, economic analyses, and environmental considerations performed in Stage 2 with the following exceptions: No additional field surveys are scheduled for Stage 3. In addition, an Environmental Impact Statement will be prepared. Option A for implementing Section 404 of the Clean Water Act will be used. Under this option, the proposed project world be reevaluated during advanced engineering and design using the Section 404(b)(1) guidelines. The schedule of Stage 3 activities for the Final Report is shown on the Study Flow Network (CPM), Exhibit J2 of Appendix J.

PUBLIC INVOLVEMENT AND COORDINATION

Coordination will continue to be maintained with affected Federal, State, regional, county, and local agencies. At the conclusion of the Reconnaissance Report, but before the report was finalized and distributed, a Public Meeting was held at a centralized location in the study area. Details of this meeting are provided below.

Subsequent coordination will involve a series of technical workshops with the Ohio Department of Natural Resources and USF&WLS on the Maumee Bay and East Harbor State Park studies. In addition, the draft survey reports and DEIS for the Maumee Bay Interim and the Final Report will be coordinated with Federal and State agencies and the public late in Stage 3. Public meetings will be conducted soon thereafter if comments received on the two reports indicate such action is necessary.

Public Meeting

A public meeting was held in Oak Harbor, OH, on 4 June 1981. Prior to the meeting an information packet was prepared and mailed to the affected Federal, State, regional, county, and local agencies as well as residents who had previously shown an interest in the study. This information packet presented a brief synopsis of each of the areas investigated during the reconnaissance study and provided summary financial information.

Approximately 45 people attended the public meeting. The study purposes were defined after which a brief review of the areas investigated and the resulting findings were presented. After the presentation by the Corps, those in attendance were invited to make statements. No major disagreements with the study findings were voiced, although several local farmers repeated their concerns over flooding of their farmlands.

One participant, a farmer in Carroll Township, requested the Corps to visit his farm for a first-hand look at the problem area. A visit was made on the following day. The problems experienced by this farmer were typical of many in the area, and are caused by the following conditions, alone or in combination: (a) higher than average Lake Erie levels, (b) winds from the northeast which temporarily raise the water levels at the western end of Lake Erie (called "wind setup"), and (c) excessive runoff due to heavy rains or rapid thaws.

When these conditions occur, the internal drainage system is over stressed, and flooding of agricultural lands takes place. Local farmers have constructed individual dikes and pumping stations, but have been only partially successful in preventing flooding. The Soil Conservation Service has and will continue to provide technical and limited financial assistance.

The public meeting concluded with the recommendation that no further study of flooding be accomplished under this authorization. Further study of shoreline erosion will be performed at the State Parks at Maumee Bay and East Harbor.

STUDY SCHEDULE

Study Schedule

The Western Lake Erie Shore Study was authorized by resolution of the Public Works Committee of the House of Representatives on 11 April 1974. The study was initially funded in Fiscal Year 1979 and has received optimal funding through Fiscal Year 1981. However, as a result of negative findings for further study of flooding in this Stage 1 Report, insufficient funds have been provided in the President's Fiscal Year 1982 budget to complete the Maumee Bay State Park Interim, and initiate Stage 2 for the Final Report and East Harbor State Park. Because of the State of Ohio's stated priority to complete the Maumee Bay State Park Interim Report as expeditiously as possible, the contemplated Fiscal Year 1982 funds have been allocated thereto, and initiation of Stage 2 for East Harbor State Park has been deferred until Fiscal Year 1983. The schedules presented herein assume that optimal funding will be provided between Fiscal Year 1983 and study completion in early Fiscal Year 1986.

Assuming optimal funding beyond Fiscal Year 1982, Table E1 following, is a schedule of study milestones for the Maumee Bay Interim Report and the Final Report. These milestones are as defined in Corps regulation ER 18-2-2, and are intended to identify completion of significant study phases.

Table E1 - Milestone Schedules for Western Lake Erie Shore Reports

Milestone	Scheduled Completion Date: Maumee Bay State Park Interim Report on Shoreline Erosion	Scheduled Completion Date: Final Report, Including Report on East Harbor State Park
Stage 1		
01 - Study Initiation		October 1978
02 - Approval of Reconnaissance Report		April 1981
Stage 2		
03 - Submission of Stage 2 Document to Division	October 1980	November 1983
04 - Stage 2 Checkpoint Conference	November 1980	December 1984
05 - Completion of Action on MFR	December 1980	February 1984
Stage 3		
06 - Submission of Draft Feasibility Report (Including DEIS to Division	December 1981	March 1985
07 - Stage 3 Checkpoint Conference	February 1982	May 1985
08 - Completion of Action on MFR	March 1982	June 1985
09 - Coordination of Draft Feasibility Report and DEIS	April 1982	August 1985
10 - Submission of Final Feasibility Report and RDEIS to Division	October 1982	November 1985
11 - Release of Division Engineer's Public Notice. Submission of Report to BERH.	December 1982	December 1985

SECTION F
CONCLUSIONS

In considering the problems, needs, and opportunities in the 60-mile reach of Lake Erie shoreline between the Michigan-Ohio line and Marblehead, Ohio covered during Stage 1 of the Western Lake Erie Shore Study, it was determined that the primary water and related land resources concerns in this study area are shoreline erosion, lake flooding, recreational boating, and water-oriented general recreation. During Stage 1 screening of these concerns as they apply to site-specific locations, the emphasis was placed on identifying those problems areas where further study appears warranted based primarily on the significance of the problem and probable economic justification of a water resources project. As was discussed in Section B, a preliminary evaluation of the identified problem areas indicated that further consideration should be given to five flood problem areas and two locations where erosion adversely affects recreational facilities. Plans were then formulated and evaluated for these seven locations. As a result of this iterative process in Stage 1, the following conclusions were reached regarding the expressed concerns:

1. Shoreline Erosion - Erosion is a serious problem and of significant concern along much of the shoreline in the study area. As a result, protective works have been constructed along much of the shoreline by public and private interests. Based on the considerations of Stage 1, it was concluded that erosion problems at Maumee Bay State Park and East Harbor State Park should be considered further under the Western Lake Erie Shore Study authorization.

2. Lake Flooding - Almost all of the shoreline within the 60-mile reach of study area is subject to flooding. Areas of greatest concern are those where residential development is concentrated. Based upon the investigations performed in Stage 1, it is concluded that new, viable plans of improvement cannot be generated for any of the flood problem areas in the study area. Therefore, no further consideration will be given to additional study of flooding at this time.

3. Recreational Navigation - Based on the considerable interest expressed, and recent recreational boating demand studies, there is a significant need for additional small-boat harbor facilities in the study area. The District concludes that this need should be pursued under the Lake Erie Coast study which presently provides the authority to perform studies of recreational navigation needs along the entire United States shoreline of Lake Erie. Therefore, no further consideration will be given to recreational navigation during the continuation of Western Lake Erie Shore Study.

4. General Recreation - There is a need for additional recreational facilities and opportunities in the study area. The potential shore erosion

projects at Maumee Bay and East Harbor State Parks, for which feasibility studies will be completed under the Western Lake Erie Shore Study authority, will contribute significantly to meeting the recreational need in the study area if authorized and constructed. No other locations for developing additional recreational facilities were identified or considered during this Stage 1 Study.

CONTEMPLATED STUDY DIRECTION

Based on the results of the planning effort to present, it has been determined that further study of the shoreline/beach erosion problems at Maumee Bay and East Harbor State Parks should be undertaken.

The Stage 2 feasibility study for Maumee Bay State Park was performed concurrently with this Stage 1 effort, based on these results, and Stage 3 has been initiated. It is envisioned that the ultimate selected plan for Maumee Bay State Park will incorporate a 5,500-foot sand beach over the western half of the park and a 5,500-foot stone revetment along the eastern half of the park. The Final Interim Feasibility Report for Maumee Bay State Park is scheduled to be completed (Milestone 11) in December 1982.

Stage 2 and Stage 3 studies of beach erosion at East Harbor State Park will be performed as part of the Final Report studies. Stage 2 of this Final Report is presently scheduled to be completed in the 2nd Quarter of Fiscal Year 1984, and the Final Feasibility Report in the 1st Quarter of Fiscal Year 1986, assuming that optimum funding is provided.

LOCAL SUPPORT

The Ohio Department of Natural Resources, prospective local sponsor for the potential shoreline/beach erosion projects at Maumee Bay and East Harbor State Parks, strongly supports the studies at both locations. There is no stated opposition to further studies or projects at either site.

POLICY AND OTHER ISSUES TO RESOLVE

There are no policy or other issues to be resolved at this time.

SECTION G
RECOMMENDATIONS

It is recommended that this Reconnaissance Report for the Western Lake Erie Shore Study be approved. In addition, it is recommended that Stage 3 of the Interim Report on Shoreline Erosion/Beach Restoration for Maumee Bay State Park proceed as scheduled, and Stage 2 of the Final Report which emphasizes beach erosion at East Harbor State Park be initiated in Fiscal Year 1983 contingent upon appropriate funding.

GEORGE P. JOHNSON
Colonel, Corps of Engineers
Commander and District Engineer

WESTERN LAKE ERIE SHORE FEASIBILITY STUDY

APPENDIX A

HYDROLOGY, HYDRAULICS AND FLOOD DAMAGES

U.S. Army Engineer District, Buffalo
1776 Niagara Street
Buffalo, New York 14207

WESTERN LAKE ERIE SHORE FEASIBILITY STUDY
APPENDIX A
HYDROLOGY, HYDRAULICS AND FLOOD DAMAGES

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APPENDIX A
HYDROLOGY, HYDRAULICS AND FLOOD DAMAGES

HYDROLOGY

A1. CLIMATOLOGY

The climate is typical of the northern mid-continent but is modified by the proximity of Lake Erie. Temperatures range from a high of 105°F to a low of -16°F. Mean daily temperatures range from 74.6°F during July to 28.8°F in January.

Mean annual precipitation is 31.06 inches, with a daily maximum of 12 inches recorded in 1969 at the Port Clinton Water Works.

In the study area there are two water level gages on Lake Erie. They are located at Toledo and Marblehead. Daily readings at Toledo and Marblehead have been recorded since 1941 and 1960, respectively.

A2. FLOOD PRODUCING FACTORS

The level of Lake Erie varies from year to year and also from month to month, depending upon the volume of water in the Great Lakes system. The lake level is also subject to sudden, spectacular "rises" or "drops" in water levels which occur as the result of strong winds blowing over this large mass of water, significant differences in barometric pressure, or combinations of these forces. Strong winds act to tilt the lake's surface, causing the water to be low at one end and high at the other. Because of its shallowness, the western end of Lake Erie affords little opportunity for storm impelled water to return through reverse currents beneath the surface disturbed by storms. As a result, the water level in the harbors, particularly those near each end of the lake, fluctuates markedly under the influence of the winds, varying with the direction, strength, and persistence of the wind. In extreme cases, these "wind setups" have produced differences of over 13 feet between lake levels at Buffalo, NY, and Toledo, OH. The principal flood problem along the shoreline is high water levels of Lake Erie created by a combination of abnormal still water levels and wind setup from the northeast. The normal still water level for Lake Erie at Toledo is elevation 570.8 on International Great Lakes Datum (IGLD). The maximum instantaneous flood level on Lake Erie at Toledo was elevation 576.68. It occurred on 14 April 1980.

A3. FLOODS OF RECORD

The most severe floods of recent record occurred in the fall of 1972 and spring of 1973. Notable floods have occurred along the Western Lake Erie shoreline on 27 April 1966, 14 November 1972, 9 April 1973, 8 April 1974, and 14 April 1980. High flood levels on Lake Erie are shown in Table 1.

Table 1 - Maximum Instantaneous Flood Elevations on Lake Erie

Date	Toledo Gage Elev. (IGLD)	Marblehead Gage Elev. (IGLD)
27 April 1966	575.64	572.74
14 November 1972	575.98	575.18
9 April 1973	576.67	574.87*
8 April 1974	576.58	575.23
14 April 1980	576.68	574.38*

* Maximum hourly level for date

A4. STAGE-FREQUENCY CURVES - LAKE ERIE

Stage-frequency curves for Lake Erie at Oregon, Port Clinton, Sand Beach, Long Beach, and Locust Point were developed from Plate 4 in "Report on Great Lakes Open-Coast Flood Levels," prepared by the U.S. Corps of Engineers, Detroit District in February 1977. These stage-frequency curves are shown on Figures A1 and A2.

Waves produced on Lake Erie during northeast storms compound high water levels produced by these storms and create extensive flooding and storm damage problems along the shoreline.

Waves heights for various Lake Erie water levels were established. It was assumed that only houses along the immediate shoreline would be affected by waves. Most of the residences abutting the lakeshore have some type of protective sea wall structure which may be damaged during the storm. Although these residences generally are situated on high ground, additional damages are incurred from wind-driven waves and flood waters flowing inland which cause soil erosion and deposit debris.

A5. DAMAGES UNDER EXISTING CONDITIONS

Damage Survey - A detailed damage survey for Oregon and Port Clinton was conducted by the Buffalo District during June-July 1979. A similar survey was conducted at Sand Beach, Long Beach, Locust Point in Carroll Township in February 1981. The results of these damage survey were used as the basis for determining average annual flood damages from estimated future flood occurrences and benefits that would result from the considered plan of improvement. All elevations are on International Great Lakes Datum (IGLD).

Reach Limits - The location of each reach and the initial damage elevation are presented in Table 2.

Table 2 - Damage Reaches

Location	Inital Damaging Elevation (IGLD)	Recurrence Interval In Years	Limits of Reach
Oregon	574.0	3.0	Along shoreline from Harbor View to Norden Road, Oregon
Locust Point	573.0	2.0	Along Township Route 237 south of canal to Turtle Creek Bay, Carroll Township
Long Beach	572.5	1.5	Along Hollywood Street and Long Beach Road, Carroll Township
Sand Beach	573.0	2.0	Along Division Street, Carroll Township
Port Clinton	571.0	1.25	5,000 feet west of Port Clinton city line to 3,200 feet northeast of the Portage-Catawba Island town line

A6. METHODOLOGY

Residential - The value, type of structure, and first floor elevation of each affected unit was established from field survey and inspection. The value of household contents was taken as 33 percent of the structural value. The estimates of structural and content value considered the location of each unit relative to the neighborhood in terms of proximity to commercial development, schools and churches, general appearance of the structure, and the nature and extent of landscaping and other improvements. The values of several properties were checked with local realtors.

Damages were estimated at various flood depths based on depth-percent damage relationships. The initial damage elevation was defined as the flood height at which water entered the unit's lowest opening. Damages to the units were based on cost of repair, the depreciated value or cost of replacement.

Commercial - All commercial damage estimates are based on personal interviews and include estimated damages to machinery and inventory, lost wages, damage, and anticipated cleanup costs. During the interviews with owners and/or managers of commercial units, field personnel documented the overall condition of the building and equipment as well as the type and value of inventory.

Public and Other - The estimated damages to public facilities such as buildings, roads, bridges, and utilities were determined by calculated flood

depths and field observations. Corps field personnel interviewed city officials in Oregon and Port Clinton. Municipal losses were prepared by responsible local officials who had direct knowledge of the flood damages. Emergency operations and cleanup cost incurred by local, State, and Federal agencies were estimated based upon physical characteristics of the flooding (e.g., flood depths and durations), the flood emergency activities of the affected area, and field observations.

The stage-damage curves are shown on Figures A3 to A9.

A7. AREAS AFFECTED BY FLOODING

In Oregon, 215 residences and 3 commercial units would be affected by the 100-year level (Elev. 576.4) on Lake Erie. The average first floor elevation of these residences is 577.5. They have an average value of $25,000.

In Locust Point, 130 residences and 3 commercial units would be affected by the 100-year level (Elev. 576.0) on Lake Erie. The average first floor elevation of the residences is 576.3. They have an average value of $23,000.

In Long Beach, 115 residences would be affected by the 100-year level (Elev. 576.0) on Lake Erie. The average first floor elevation of these residences is 576.6. They have an average value of $41,000.

In Sand Beach, 100 residences would be affected by the 100-year level (Elev. 576.0) on Lake Erie. The average first floor elevation of these residences is 577.3. They have an average value of $37,000.

In Port Clinton, 675 residences and 90 commercial units would be affected by the 100-year level (Elev. 576.0) on Lake Erie. The average first floor elevation of these residences is 577.4. They have an average value of $17,000. There were many trailers in this study area.

A8. AVERAGE ANNUAL DAMAGES

The average annual damages were developed based on stage-frequency relationships and stage-damage information. HEC computer program 761-X6-L7580, "Expected Annual Flood Damage, dated June 1977, was used to compute average annual damages. The average annual damages are the expected value of flood damages for any year. The average annual flood inundation damages for existing conditions are presented in Table 3.

Table 3 - Estimated Average Annual Damages, Existing Conditions

Location	Residential	Commercial	Public and Other	Total
	$	$	$	$
Oregon	25,410	0	2,130	27,540 1/
Port Clinton	84,000	63,890	3,470	151,360 1/
Sand Beach	28,630	0	0	28,630 2/
Long Beach	34,600	0	0	34,600 2/
Locust Point	26,100	0	0	26,100 2/

1/ Based on July 1979 price levels

2/ Based on February 1981 price levels

A9. EXISTING FLOOD PROTECTION MEASURES

Flood protection measures in the mainland portion of Lucas and Ottawa Counties affected by the Lake Erie floods generally take the form of concrete and rubble breakwalls and are typical of many areas along the western shore of Lake Erie. These walls were installed primarily as erosion control measures, but they serve to provide flood protection by stopping the advance of wave action from the lake. Walls and other shore protection methods are generally installed by private owners and their effectiveness is dictated by the care and extent of construction.

Flood protection in the interior portions of these counties consists of a drainage system made up of large ditches, or storm sewers in more developed areas, which drain into Lake Erie or one of the major streams in the area. Many land areas used for farming or occupied by buildings are protected by dikes constructed by the Soil Conservation Service.

K+E PROBABILITY X [illegible]IVISIONS KEUFFEL & ESSER MADE IN U.S.A. 46 8000

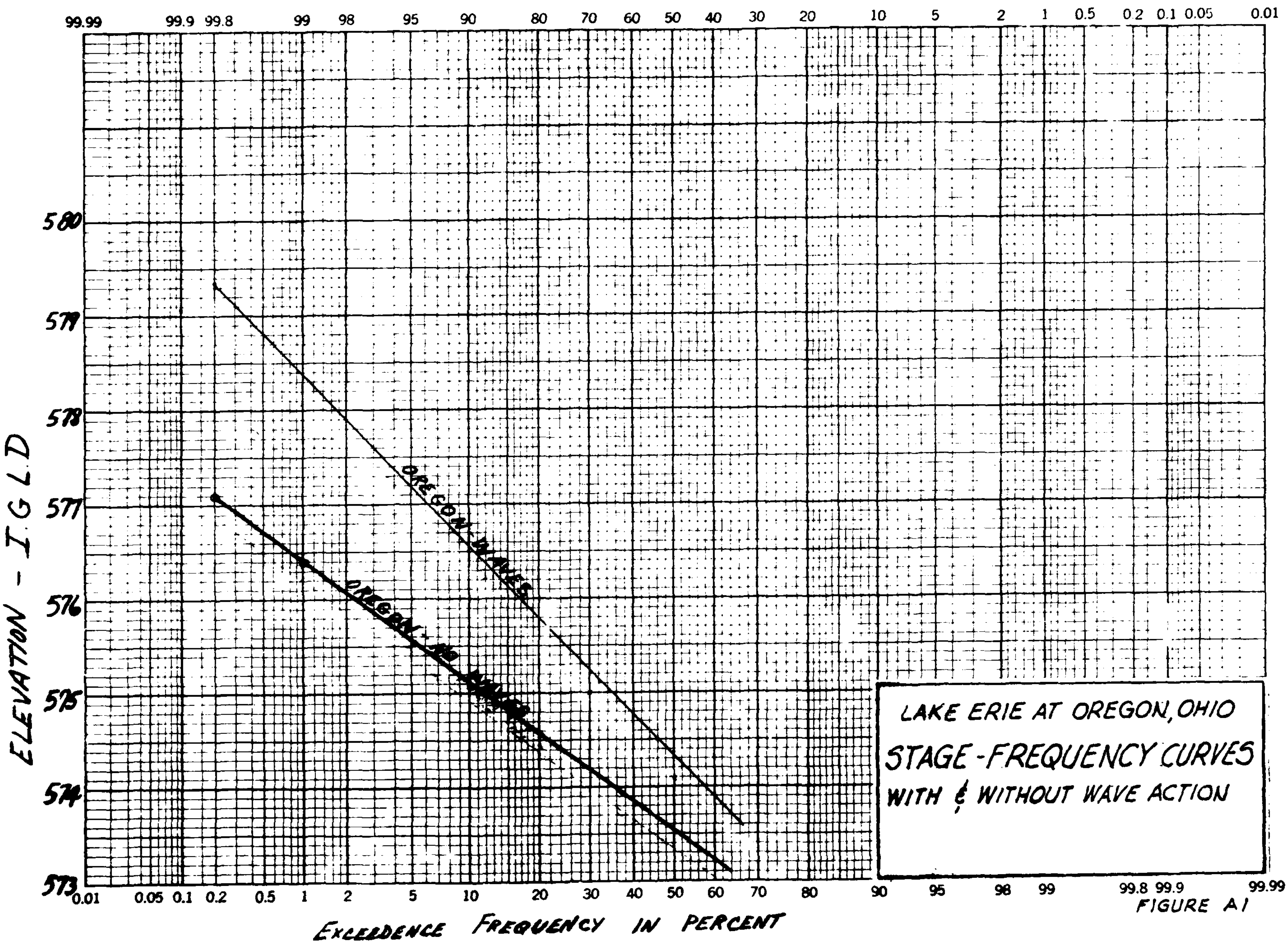
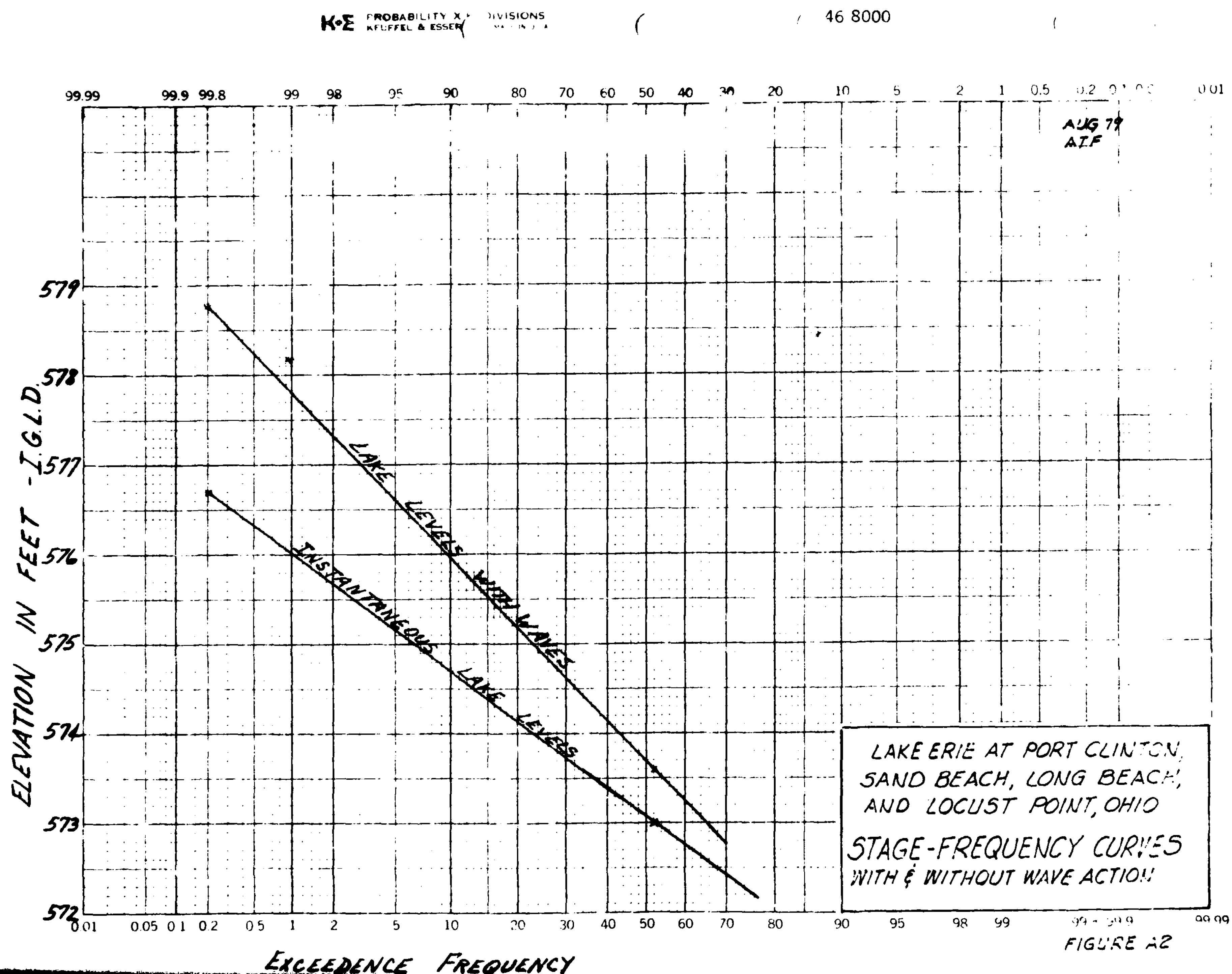


FIGURE A1



K•E PROBABILITY X DIVISIONS
KEUFFEL & ESSER
46 8000
AUG 79
AIF
LAKE LEVELS WITH WAVES
INSTANTANEOUS LAKE LEVELS
ELEVATION IN FEET - I.G.L.D.
EXCEEDENCE FREQUENCY
LAKE ERIE AT PORT CLINTON, SAND BEACH, LONG BEACH, AND LOCUST POINT, OHIO
STAGE-FREQUENCY CURVES WITH & WITHOUT WAVE ACTION

FIGURE A2

AD-A104 227 CORPS OF ENGINEERS BUFFALO NY BUFFALO DISTRICT F/G 13/2
WESTERN LAKE ERIE SHORE STUDY, OHIO. RECONNAISSANCE REPORT (STA--ETC(U)
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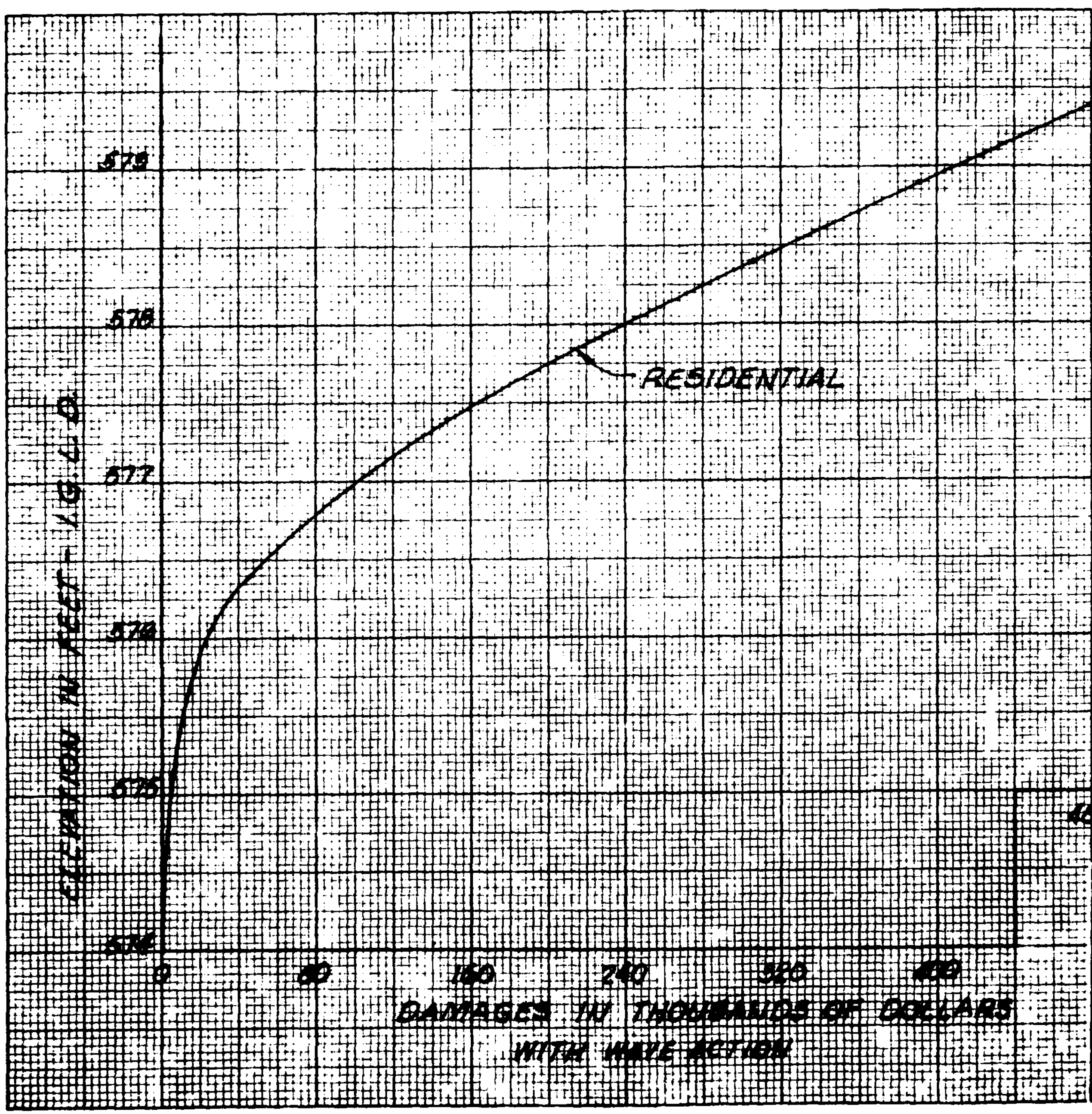


OREGON, OHIO

STAGE-DAMAGE CURVE

WITH WAVE ACTION

FIGURE A8

K•E 20 X 20 THE INCH KEUFFEL & ESSER CO. 46 1240

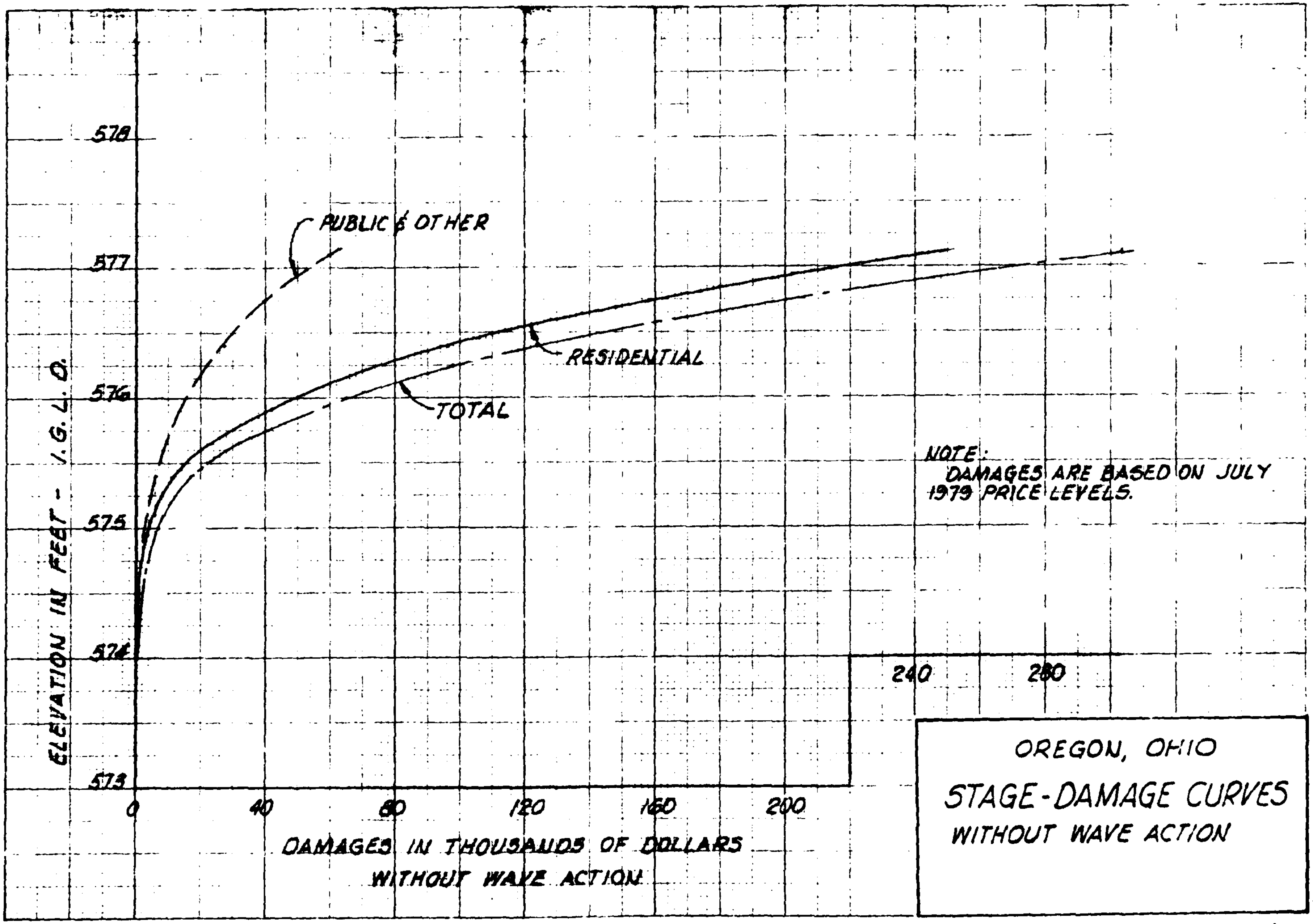
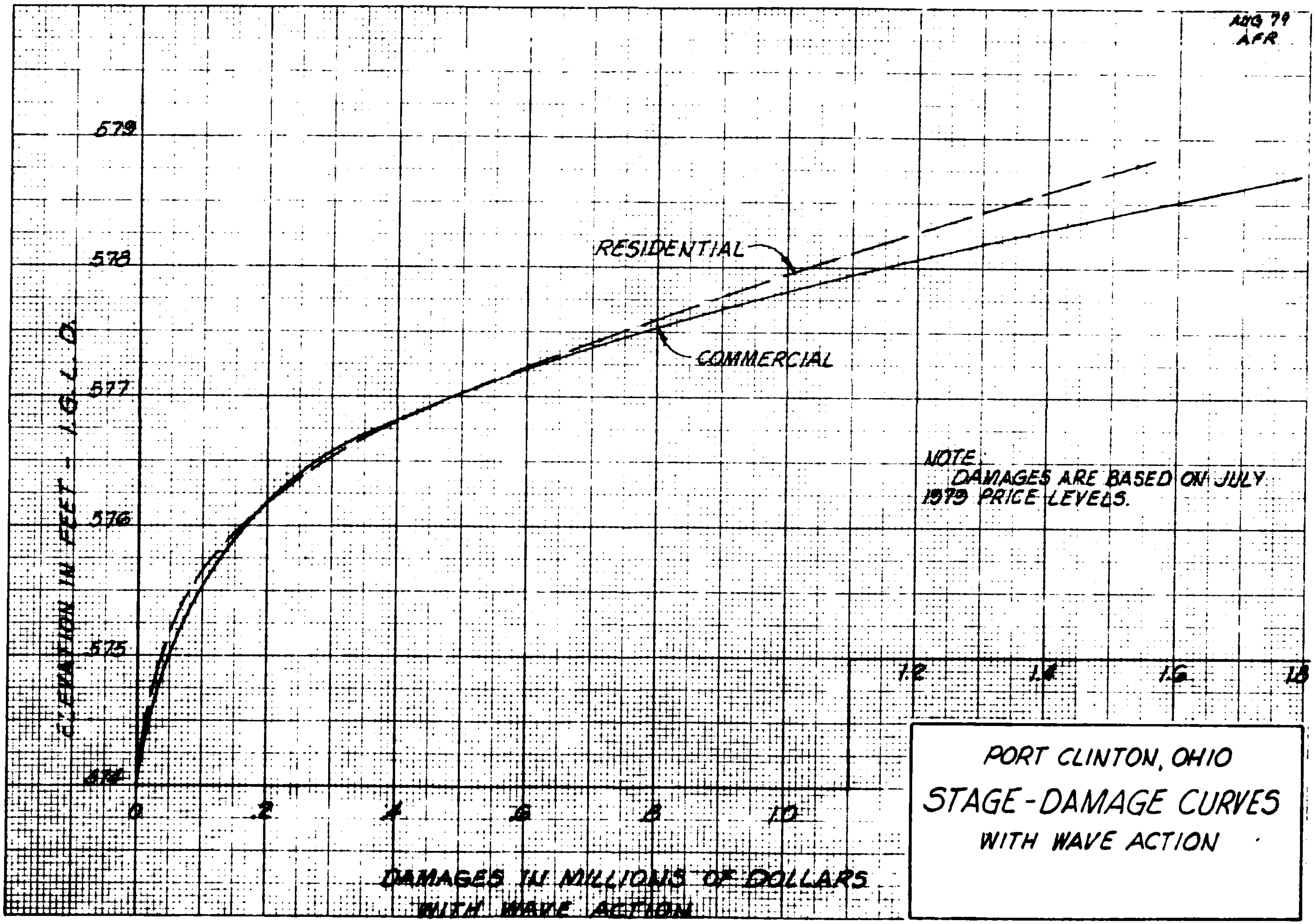


FIGURE A4

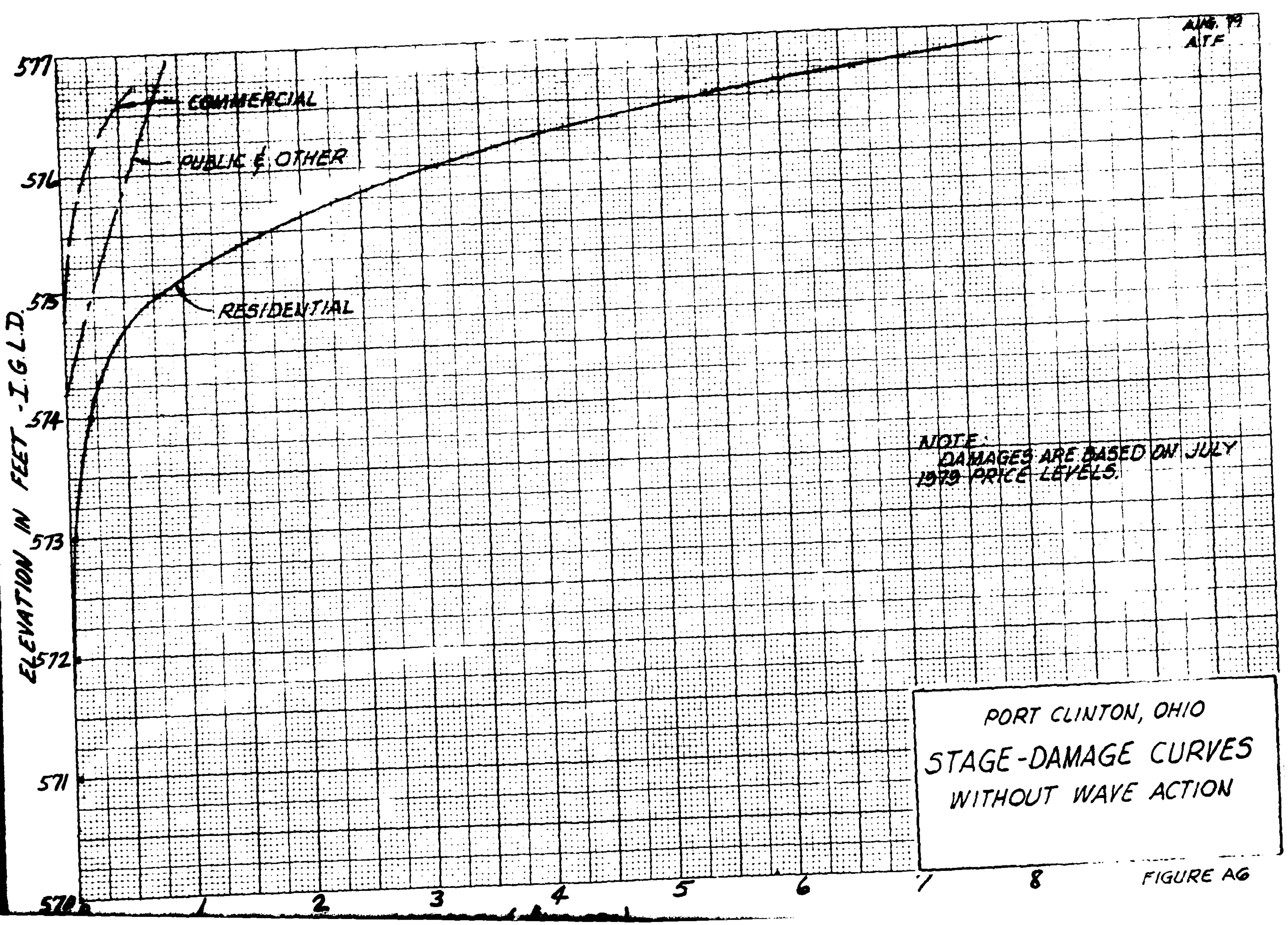


PORT CLINTON, OHIO

STAGE-DAMAGE CURVES

WITH WAVE ACTION

FIGURE A5



K•E 10 X 10 TO ½ IN. KEUFFEL & ESSER
7 X 10 INCHES MADE IN U.S.A.
46 1320
AUG. 79
ATF
577
576
575
574
573
572
571
570
ELEVATION IN FEET - I.G.L.D.
COMMERCIAL
PUBLIC & OTHER
RESIDENTIAL
NOTE:
DAMAGES ARE BASED ON JULY 1979 PRICE LEVELS.
1
2
3
4
5
6
7
8
PORT CLINTON, OHIO
STAGE-DAMAGE CURVES
WITHOUT WAVE ACTION

FIGURE A6

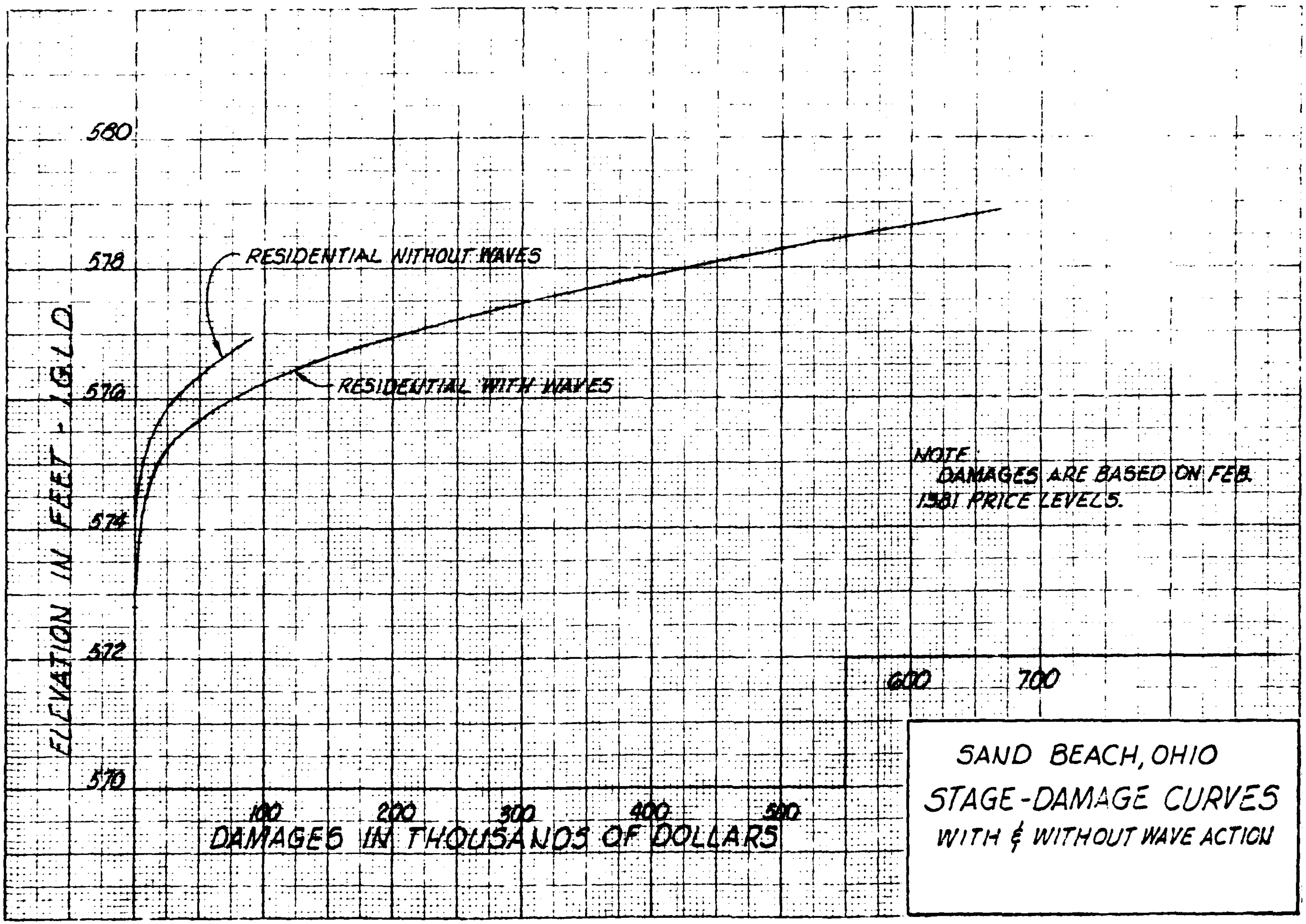
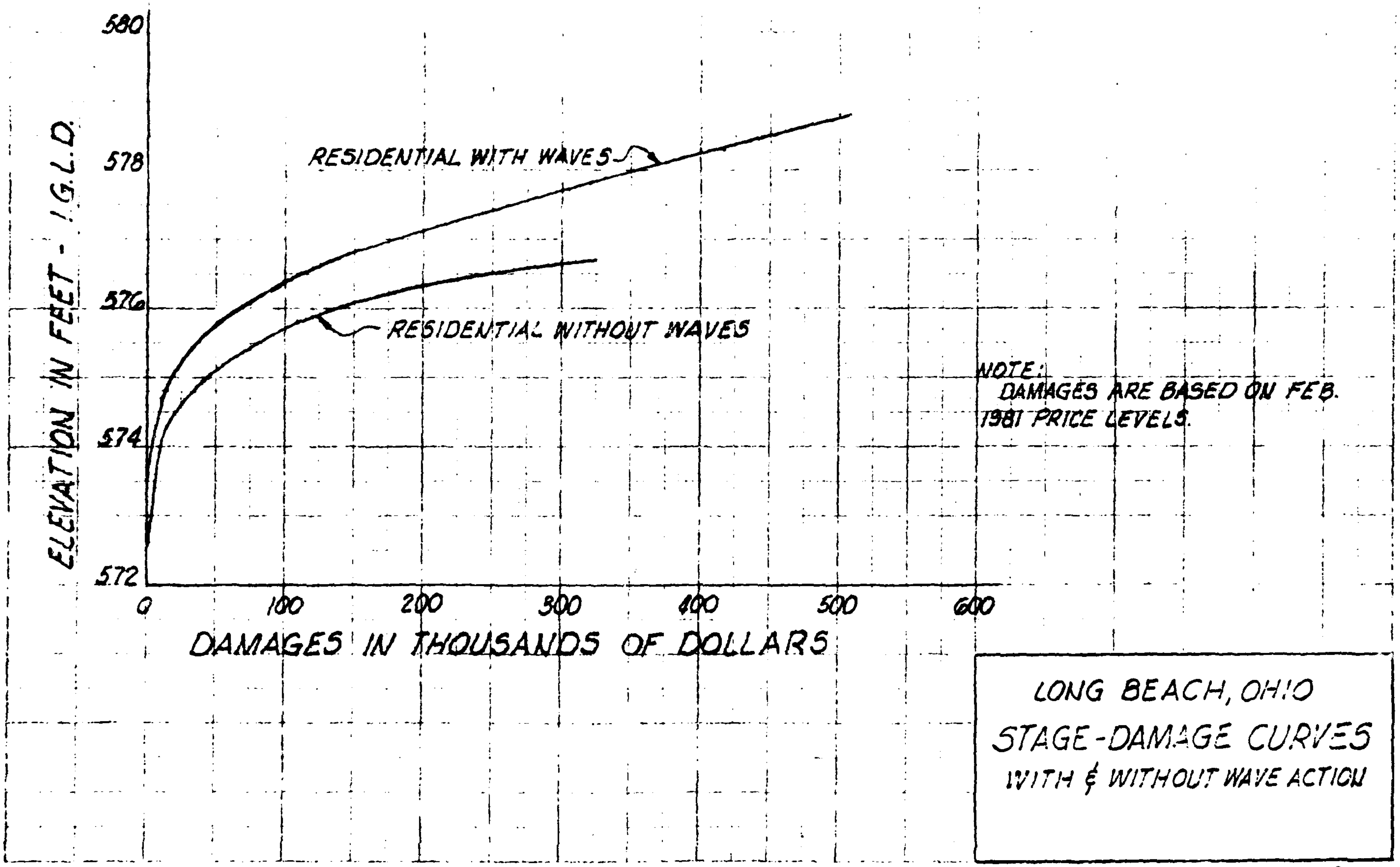

580
578
576
574
572
570
ELEVATION IN FEET - IGLD
RESIDENTIAL WITHOUT WAVES
RESIDENTIAL WITH WAVES
NOTE
DAMAGES ARE BASED ON FEB. 1981 PRICE LEVELS.
100
200
300
400
500
600
700
DAMAGES IN THOUSANDS OF DOLLARS
SAND BEACH, OHIO
STAGE-DAMAGE CURVES
WITH & WITHOUT WAVE ACTION

FIGURE A7



LONG BEACH, OHIO
STAGE-DAMAGE CURVES
WITH & WITHOUT WAVE ACTION

FIGURE A8

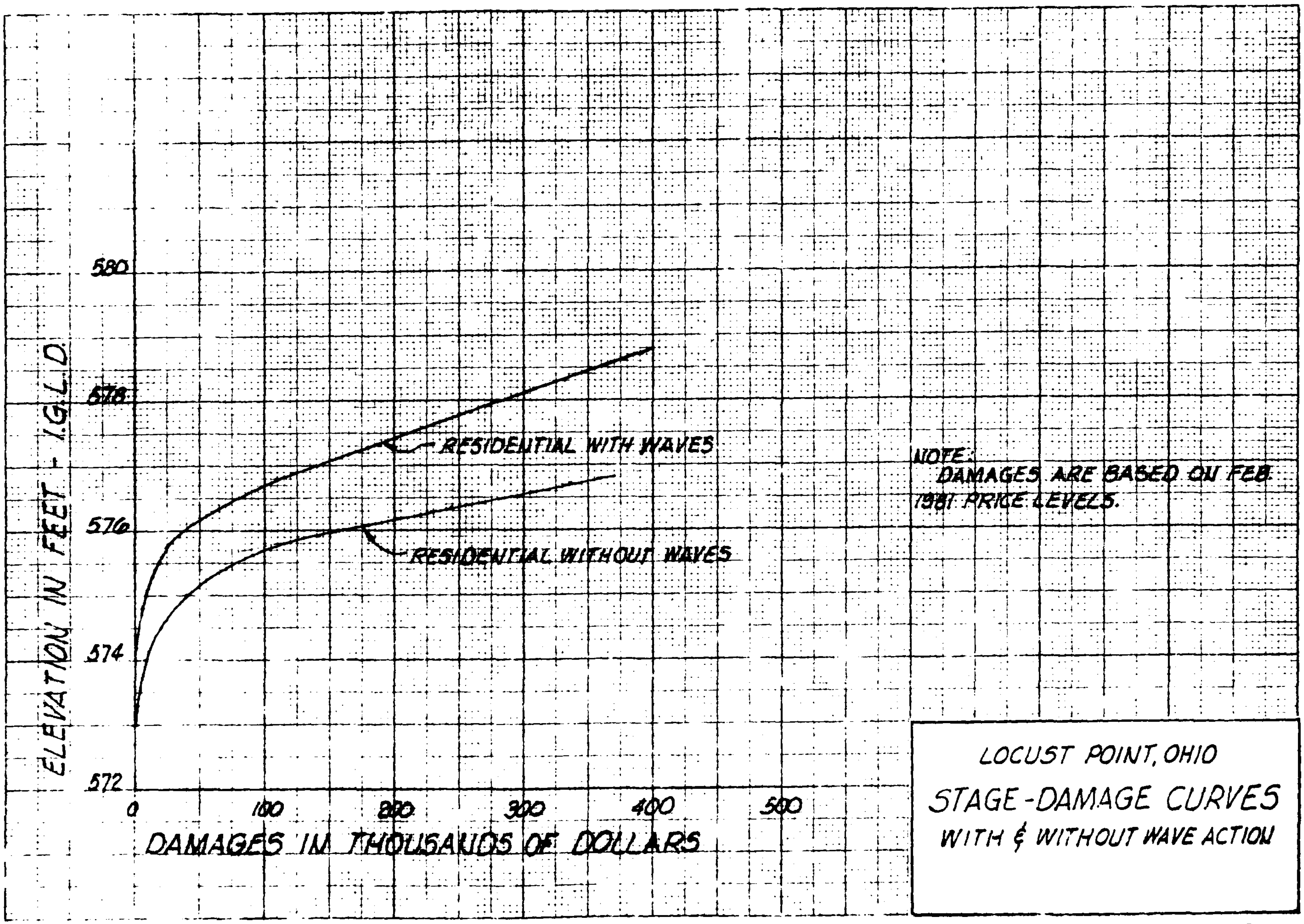

580
578
576
574
572
ELEVATION IN FEET - I.G.L.D.
0
100
200
300
400
500
DAMAGES IN THOUSANDS OF DOLLARS
RESIDENTIAL WITH WAVES
RESIDENTIAL WITHOUT WAVES
NOTE:
DAMAGES ARE BASED ON FEB. 1981 PRICE LEVELS.
LOCUST POINT, OHIO
STAGE-DAMAGE CURVES
WITH & WITHOUT WAVE ACTION

FIGURE A9

WESTERN LAKE ERIE SHORE, OH

STAGE I - RECONNAISSANCE

APPENDIX B

ECONOMICS

Project Economists
Sharon L. Cooper
Ronald J. Guido

WESTERN LAKE ERIE SHORE, OHIO
STAGE I - RECONNAISSANCE

APPENDIX B
ECONOMICS

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APPENDIX B

B1 - DELINEATION OF THE AFFECTED AREA

B1.1 The affected area for the flood control project consists of the flood plain plus all other areas likely to serve as alternative sites for any activity which may use the flood plain if it were protected. The delineation of the affected area was determined by examining existing land use and the future expected development. The West Coast of Lake Erie comprises approximately 60 miles of shoreline from the Ohio-Michigan State line to Marblehead, OH. The flood plain lies entirely within the counties of Lucas and Ottawa in the State of Ohio. The existing shoreland uses for the area are shown in Table B1. In Lucas County, the city of Toledo, the nation's 34th largest city, is located at the southwestern corner of Lake Erie where the Maumee River empties into the Maumee Bay. The city of Oregon is easterly adjacent to Toledo with its northern shoreline along Maumee Bay. The proposed Maumee State Park is located along the shore of Maumee Bay partially in the city of Oregon extending easterly into the town of Jerusalem. Next, continuing easterly, is Cedar Point National Wildlife Refuge along the shores of Maumee Bay and Lake Erie followed by the Reno Beach-Howard Farms area, the Metzger Marsh Wildlife area, and part of the Ottawa National Wildlife Refuge. This ends riparian lands in Lucas County. Continuing eastward along the shore of Lake Erie are the townships of Carroll, Erie, the city of Port Clinton, the townships of Portage, Catawba Island, Danbury, and the city of Marblehead. Also included in Ottawa County is Put-In-Bay Township which includes the islands of North Bass, Middle Bass, and South Bass. Kelley's Island, located north of Marblehead in Erie County, is also included in this study. An area description map is shown on Plate B1.

a. Residential

B1.2 The affected area for residential activity for the West Coast of Lake Erie was delineated by similarity of housing stock. The centers of population along the flood plain are the city of Toledo, the city of Oregon, and the city of Port Clinton. Table B2 shows the characteristics of the units in structure for the above cities. The majority of housing units are single-unit dwellings. Alternative location sites for single-unit housing located nearest to the flood plain are the city of Maumee, the city of Rossford, the city of Sylvania, the village of Waterville, the village of Whitehouse, Monclova Township, Springfield Township, Sylvania Township, Bedford Township, and Perrysburg Township. The city of Perrysburg is not expected to experience any growth, but the township itself is developing at a fast pace. Both Springfield and Monclova Townships are expected to experience growth in the construction of single-unit housing. Table B3 shows the percent owner occupied for single-unit dwellings. The likelihood of development in these areas is based on population trends and building permit statistics. From the 1970 Census of Housing, it is determined that the city of Maumee and the city of Sylvania are suitable alternative sites because 88 percent and 78 percent, respectively, of housing units are single-unit structures. Table B4 shows the housing, single and two/multi-units that have been constructed between 1970 and 1975. These areas are the areas that have been trended to grow in residential activity.

Table B1 - Shoreland Uses

Shoreland Use Category	Existing Shoreline: Miles of Shoreline	Existing Shoreline: Percent of Total
Economic Uses		
Residential	25.6	42.7
Industrial & Commercial	3.2	5.3
Agricultural & Undeveloped	9.7	16.1
Public Buildings & Related Land	3.5	5.8
Recreational Uses		
Parks	8.6	14.3
Environmental Uses		
Wildlife Preserves & Game Lands	7.1	11.9
Fish & Wildlife Wetlands (Offshore)	N/A	
Forest	2.3	3.9
Total	60	

SOURCE: Areawide Development Plan TMACOG December 1977, p. VIII-2.

Table B2 - Housing Data

Area	Units in Structure: All year-round units: 1	2 or More	Mobile Home	Total	Owner Occupied: 1	2 or More	Mobile Home	Total	Renter Occupied: 1	2 or more	Mobile Home	Total
City of Toledo	89,153	39,180	1,983	130,316	75,715	4,966	1,505	82,186	11,721	30,979	478	43,178
City of Oregon	4,229	1,246	19	5,494	3,743	54	76	3,873	426	464	24	914
City of Port Clinton	1,843	588	19	2,450								
Point Place, Toledo	1,515			1,515	1,195			1,195	310			310
Lucas County	114,769	42,224	2,750	159,743	97,808	5,305	2,137	105,250	47,144	141	1,357	48,639
City of Maumee	4,070	466	79	4,615	3,638	87	34	3,759	384	353	45	782
City of Sylvania	2,700	761	2	3,463	2,424	13	1	2,438	218	669	1	888
Village of Northwood	1,041	59	258	1,358				1,142				186
City of Perrysburg	2,150	381	-	2,531				1,867				562
City of Rossford	1,482	258	4	1,744				1,325				378
Village of Waterville	726	102	-	828				667				151

SOURCE: 1970 Census of Housing, OH, U. S. Dept. of Commerce p. 20, 94, 98, 106, 147, 148, 149.

Table B3 - Percent Single Units Owner Occupied

Area	Total	Single	% Owner
City of Toledo	130,316	75,715	.58
City of Oregon	5,494	3,743	.68
City of Port Clinton	2,450		
City of Toledo, Point Place	1,515	1,195	.79
City of Maumee	4,615	3,638	.79
City of Sylvania	3,463	2,424	.70

SOURCE: Table B2

Table B4 - Building Permits

Area	1970 Single	1970 Two/Multi	1970 Total	1971 Single	1971 Two/Multi	1971 Total	1972 Single	1972 Two/Multi	1972 Total	1973 Single	1973 Two/Multi	1973 Total	1974 Single	1974 Two/Multi	1974 Total	1975 Single	1975 Two/Multi	1975 Total	Total Single	Total Two/Multi	Total Total
Village of Northwood	3	0	3	3	0	3	12	0	12	26	35	61	132	0	132	71	0	71	247	35	282
City of Perrysburg	16	35	51	37	24	61	142	0	142	103	49	152	35	4	39	54	20	74	387	132	519
Township of Perrysburg	9	0	9	13	0	13	27	0	27	14	0	14	21	0	21	82	72	154	166	72	238
City of Maumee	28	42	70	68	38	106	43	63	106	32	38	70	62	10	72	61	80	141	294	271	565
Monclova Township	22	78	100	18	14	32	48	0	48	32	14	46	20	30	50	19	0	19	159	136	295
City of Oregon	80	194	274	149	150	299	219	188	407	69	8	77	39	4	43	79	158	237	635	702	1,337
Springfield Township	84	390	474	45	204	249	36	177	213	60	45	105	30	24	54				255	840	1,095
City of Sylvania	82	345	427	110	329	439	73	137	210	72	75	147	93	180	273				430	1,066	1,496
Sylvania Township	52	44	96	70	0	70	78	0	78	73	8	81	50	0	50				323	52	375
Village of Waterville	27	0	27	22	54	76	23	0	23	46	0	46	12	2	14	20	0	20	150	56	206
Village of Whitehouse	19	2	21	89	0	89	15	4	19	23	6	29	8	2	10	4	0	4	158	14	172
Bedford Township	102	0	102	179	0	179	184	0	184	150	5	155	95	2	97	95	0	95	805	7	812

SOURCE: Projections of Regional Growth Trends, Wallace, McHarg, Roberts and Todd Architects, October 1976, p. 45-68.

B1.3 The soil capability map for residential structures developed by the Toledo Metropolitan Area Council of Governments (TMACOG) shows that the areas of growth have variable favorability for housing residential activity. The cities of Maumee, Oregon, Port Clinton, and Toledo and the township of Monclova are characterized by restrictive soil capabilities. The assignation of very severe or restrictive soil limitation capability does not preclude residential activity, but the cost will be high since there will be a necessity of developing engineering solutions to overcome the problem without damaging the environment. The city of Sylvania has larger portions of land with very slight limitations for residential activity. Sylvania Township and Bedford Township are also better suited to residential activity than the coastal area. Majority of lands in the southern, western, and central parts of Bedford Township have very slight limitations for soil capability. The favored areas on the basis of soil capability are Bedford Township, Sylvania Township, and the city of Sylvania.

B1.4 The median value of homes is another guideline for delineating the affected area. Table B5 shows the median value of homes on the flood plain and trend growth areas. The cities of Maumee, Sylvania, Perrysburg, and Rossford are appropriate alternative sites for city of Oregon flood plain residents. The Point Place housing values correlate more closely with the city of Toledo and the village of Northwood. The Port Clinton area is not expected to experience extensive development except in Catawba Township.

B1.5 The rural areas not designated as growth regions will actually decline in population. Jerusalem Township is a prime example of a region experiencing negative growth. The village of Oak Harbor, typical of coastal residential areas, has a lower median value of homes than the Toledo area.

B1.6 The affected area for residential activity comprises the flood plain and the cities of Maumee, Perrysburg, Rossford, and Sylvania and the townships of Bedford, Monclova, Perrysburg, Lake, and Sylvania and the villages of Northwood, Waterville, and Whitehouse.

b. Industrial

B1.7 The affected area for industrial activity is the Toledo SMSA. The counties of Lucas, Wood, Fulton, Ottawa, and Monroe comprise the Toledo SMSA. The industrial sites on the flood plain include the city of Toledo, the city of Oregon, the city of Port Clinton, and the Erie Industrial Park. The city of Port Clinton, located on the southern shore of Lake Erie, has considerable employment in the manufacturing industries. The major industries are rubber and miscellaneous plastic products. Port Clinton's industrial contribution has an important effect on these industries in the region. The region is expected to increase its employment in this industry by 12.9 percent annually to 1980. Thus, Port Clinton's employment in rubber and miscellaneous will be expected to increase also. Port Clinton is a growth area in the manufacturing sector. Table B6 shows the projected growth rates in the major industries of the city. Future growth in this area can be defined as growth in the rubber and miscellaneous area industries.

Table B5 - Housing Data

Area	Total Housing Units	Median Value 1/
		$
Point Place, Toledo	1,515	15,000
City of Toledo	125,364	16,200
City of Oregon	3,551	20,300
City of Port Clinton	1,446	15,800
Village of Oak Harbor	643	15,900
Toledo SMSA	130,807	17,200
City of Maumee	3,594	21,200
City of Sylvania	2,396	26,800
City of Perrysburg	1,791	25,200
City of Rossford	1,282	20,200
Village of Northwood	820	15,500
Village of Waterville	639	22,700

SOURCE: 1970 Census of Housing, U. S. Dept. of Commerce, Bureau of the Census.

1/ Median value is in 1970 dollars.

Table B6 - Major Industries, Port Clinton, 1970

Industry	SIC	Port Clinton	Ottawa County	TMACOG Region	Regional Projection Annual Avg. Growth Rates to 1980
Rubber	30	32.0 1/	6.9	1.7	16.58
Glass and Concrete	32	4.9	8.7	4.4	0.68
Fabricated Metal	34	4.0	2.5	3.0	0.50

1/ Percent of Labor Force

SOURCE: Economic Base Analysis 1974-2000, Toledo Metropolitan Area Council of Governments (TMACOG), July 1977, p. 124.

B1.8 The city of Oregon is located near the Ohio-Michigan State line. According to the 1972 Census of Manufactures, the city of Oregon has the majority of workers concentrated in the professional sector. The durable goods manufacturing is most closely related to the Toledo SMSA. Fabricated metal products employment is of considerable importance. The principal subgroup industry is metal stamping.

B1.9 The city of Toledo is known as the "automotive parts capital of the world," a direct industrial support to the Detroit automobile industry. Toledo is also a center of the glass industry. The major manufacturing industries are as follows: transport equipment, machinery, fabricated metals, primary metals, rubber, and petroleum. Along the Maumee River, there are concentrations of petroleum refineries. Toledo's three oil refineries located on the bank of the Maumee River make Toledo the largest refining center between Chicago and the eastern seaboard. The average annual percentage growth rate in rubber manufacturing employment for the period 1965-1972 is 21.17 percent for the Toledo SMSA. The nation's average annual percentage change in rubber manufacturing employment for 1965-1972 is 3.68 percent. Rubber employment is therefore a likely future potential growth industry. Toledo is an advantageous location site for industrial activity due to its strategic location on the Great Lakes and the lower average weekly earnings in the region. From 1965-1972, the average wages have been consistently lower for the Toledo SMSA. The Port of Toledo provides the major port facilities for the region. The Port of Toledo has access to many world markets.

B1.10 The township of Erie is the location site of the Erie Industrial Park. It contains about 1,400 acres of land and is located on State Route 2. The businesses located in the park are mostly warehousing and auto-related production with Uniroyal, Inc. and USCO Services, Inc. the major employers. A new sewage treatment system was recently completed and a separate water plant serves the park. At present, the park leases its facilities for a 25-year period. This limits the possibilities of future expansion of the facilities. The alternative sites beside above cities and township for industrial activity off the flood plain are the village of Waterville and the township of Bedford.

B1.11 The village of Waterville, located on the Maumee River, has more workers than it does population. Over 80 percent of the labor force is employed in manufacturing. The glass and concrete industry predominates with approximately 68 percent of the labor force employed in this industrial sector. The township of Monclova may also be designated as an industrial growth area. There are 500 acres presently available for industrial development near Highway 475. The area also has excellent accessibility to the Toledo Express Airport. Monclova's stance toward future development is "controlled and developed growth."

Table B7 - Commercial Firms - Percentage of Net Change in Total Number of Firms

Toledo Central Business District		
Category	1974-75	1975-76
	%	%
Retail Food	+1	0
Eat and Drink	+1	-2
Department & General Merchandise	-1	0
Medical and Health	-5	-12
Legal	-3	+6
Personal Services	0	-5
Repair	-3	-2
Automotive & Service Stations	+1	-2
Hotels and Lodging	0	-3
Amusement & Recreation	+1	0

SOURCE: Polk Profiles of Change, Areawide Redevelopment Plan for the Toledo Metropolitan Area Council of Governments, December 1977, p. IV-2.

c. Commercial

B1.12 The future trend in commercial activity i- a decline in the central business district as firms relocate in outlying districts. The center of commercial activity along the West Coast of Lake Erie is Toledo. The percentage of change in 1974-75 and 1975-76 is shown on Table B7. This shows the trend of decline in the central city. A large and increasing amount of vacant land in the downtown district has been converted into parking lots. The decline in commercial activity in the CBD has occurred in the number of commercial units being vacated. Out of a total of 1,718 commercial units in the CBD in 1975, 464 or 27 percent were vacant. The rate of vacancy actually increased from 1975 to 1976 to 31.5 percent.

B1.13 According to the Polk Profiles of Change, the only theatre in downtown Toledo closed in 1977. The commercial activity in Toledo is centered around the daytime rather than the evening entertainment facilities. Downtown activities are centered around the administrative and Government activities of the city of Toledo and the county of Lucas. Three of Fortune's 500 companies' headquarters are located in downtown Toledo, including the Libbey-Owens Company, Owens Corning Fiberglass, and Owens-Illinois. A future growth area for the Toledo region in commercial activity is Springfield Township, also a future residential growth area. Catawba Township is a booming area as far as commercial activity is concerned. Port Clinton is the location of the majority of governmental and professional offices, serving as the seat of the Ottawa County Government.

B1.14 The major retailing and wholesaling activities are centered around the city of Toledo.

d. Recreation and Open Space

B1.15 The affected area for recreation and open space is defined as the State of Ohio. The parks within the flood plain include Federal, State, and municipal parks. Federal facilities include the Cedar Point National Wildlife Refuge and the Ottawa National Wildlife Refuge. The State facilities in the flood plain include Catawba Island State Park, Crane Creek State Park, East Harbor State Park, Kelley's Island State Park, and the proposed Maumee Bay State Park. Municipal parks include those in Toledo, Oregon, and Port Clinton.

B1.16 The State Park facilities for the above parks located along the West Shore of Lake Erie are boating, fishing, picnicking, ice fishing, ice boating, hunting, hiking, swimming, ice skating, camping, sledding, snowmobiling, and golfing. Maumee Bay State Park, proposed site, will offer the following recreational facilities: fishing, golfing, hiking, picnicking, swimming, and camping. The local parks in Port Clinton flood plain area provide the following recreation facilities: picnicking, outdoor games and sports, playground, tennis, and swimming. The indoor games and sports activities are not inclusive. The affected area for the recreation and open space may be defined as the distance which people are willing to travel to participate in the same activities as those offered in the flood plain parks. According to Table B8, people are willing to travel 3 hours at a maximum.

Table B8 - Maximum Travel Distance

Activity	Maximum Travel Time 1/
Bicycling	120
Boating	180
Camping	180
Fishing	120
Golf	60
Hiking	120
Hunting	120
Ice Skating	40
Picnicking	90
Playground	45
Outdoor Games & Sports	60
Sailing	105
Swimming	90
Tennis	30

1/ In minutes of travel time.

SOURCE: 1975 Ohio Statewide Comprehensive Outdoor Recreation Plan, ODNR, Recreational Planning Section, p. 58.

Thus, the entire State of Ohio may be defined as the affected area for recreation.

B1.17 The uniqueness of the Cedar Point National Wildlife Refuge and Ottawa National Wildlife Refuge precludes their location in an alternative site outside the flood plain.

B1.18 Since they are environmentally sensitive areas, there is recommended *a no-development stance* in these areas.

B1.19 The Lake Erie shoreline of Ohio includes one of the nation's most extensive areas of freshwater wetlands. Not only are they wildlife preservation areas, they also protect inland areas from storm damage. The only pair of native American Bald Eagles known to have produced offspring in Ohio in 1976, reside in the Ottawa National Wildlife Reserve.

B1.20 The wildlife refuges are also significant in that they provide a contribution to water quality. Marshlands filter sediment and consume nutrients carried by land runoff and prevent their delivery to Lake Erie where they contribute to the problem of eutrophication. The Ottawa National Wildlife Refuge features over 250 species of birds, along with a variety of mammals, reptiles, and insects. The area is managed for waterfowl migrations and nesting.

e. Agriculture

B1.21 Agriculture on the flood plain includes the production of corn, soybeans, wheat, and oats which are major crops for county-wide production in Lucas and Ottawa Counties. The counties of Lucas and Ottawa are the affected area for flood plain agricultural activities.

B1.22 Areas on the very heaviest of lake deposited soils are most highly productive of soybeans. In Jerusalem Township, there is production of corn, a major Ohio field crop. Erie Township is basically nonagricultural land, with only sparse land area used in agriculture. In Carroll Township, the flood inland plain is highly productive of corn. Catawba Township features very limited agriculture and land use maps designate the land as cropland not classified.

B1.23 Light truck farming is also carried on in Lucas County. A variety of fruits, vegetables, and berries are grown in the region. The truck farming is geared to serving the Toledo SMSA region. In Lucas County there is little shoreline agriculture and inland areas are concentrated in the truck farming activity. In Ottawa County, agriculture is limited along the shoreline and is concentrated in inland areas near the Toussaint and Portage Rivers.

B1.24 The future development for agricultural activities in Lucas and Ottawa Counties will be a decline in the percentage of farms and the number of farm acres in productive agriculture. Table B9 shows the historical 1954-1974 trend. Many of the acres in agricultural use around the Toledo

Table B9 - Proportion of Land in Farms 1954, 1959, 1964, 1969, 1974

	1954		1959		1964		1969		1974	
	% Farms	Farm Acres	% Farms	Farm Acres	% Farms	Farm Acres	% Farms	Farm Acres	% Farms	Farm Acres
Lucas County	55.1	120,991	46.0	100,885	47.5	104,283	44.8	98,521	44.7	98,329
Ottawa County	75.8	127,576	71.4	120,097	76.0	128,003	77.9	130,272	67.4	112,752

SOURCE: <u>1974 Census of Agriculture</u>, U. S. Dept. of Commerce. <u>Ottawa County Comprehensive Regional Development Plan 1970-1995</u>, 1971, p. 92-93.

metropolitan area will be encroached upon by growth in residential, commercial, and industrial activity.

f. Public and Other

B1.25 The affected area is the location site for five water treatment plants and five sewage treatment plants. In order to facilitate present and future development on Catawba Island, a new waterline will be constructed. This will alleviate the problem of inadequate water supply for this growth area.

B1.26 Another development on the flood plain is the Davis Besse Nuclear Energy Plant, built by Toledo Edison Company and the Cleveland Electric Illuminating Company. The plant services northwest Ohio. Two additional plants will be constructed and will be operational in the mid-1980's. The plants will generate sufficient electric power for the local area and a larger multi-State region. The three nuclear plants will require 600 full-time workers. This will serve as a boon to the local economy and serve as an energy support for expanding industrial, commercial, and residential activity in Toledo SMSA and Port Clinton-Catawba Island regions.

B1.27 The flood plain is serviced by a network of highways which have easy accessibility to major interstate Highways 80 and 90, and U. S. 20. The highway system is a major factor in future development.

B2 - PROJECTION OF DEMOGRAPHIC AND ECONOMIC ACTIVITIES WITHIN THE AFFECTED AREA

B2.1 Projections of demographic and economic activity were assumed to be independent of any flood control measures. The population projections which have been developed will serve as the basis for the entire analysis. Projections have been determined for the following for the period 1980-2040: Population, Employment, Commercial Employment, Manufacturing Employment, Income, and Housing. Plate B1 shows the location of towns and cities cited in this section of the report.

a. Population Projections

B2.2 The population projections were determined for the period 1980-2040 for the flood plain and the growth regions as designated by Toledo Metropolitan Area Council of Governments (TMACOG). The growth areas were determined for Lucas, Wood, and Monroe Counties. The growth sectors were defined according to the location of all approved or pending subdivisions from 1970 through 1975, the number of units in each by type, and the amount of land subdivided. The growth sectors for this study are shown in Table B10 by county, excluding Ottawa County.

B2.3 As can be expected, new development will be clustered around larger population centers. In Lucas County, population will burgeon in areas outside the city of Toledo. For Ottawa County, population is expected to grow in Catawba Island Township and areas in and near the vicinity of Port Clinton. The largest concentration of future population in the West Coast of Lake Erie area will be northwest, south, and southeast of Toledo. To the northwest lie the city of Sylvania and the township of Sylvania. The southwest growth areas include the city of Maumee, Monclova Township, and Waterville Township. The eastern growth pattern extends through the township of Perrysburg. The city of Oregon, Lucas County, attributes its growth to the expected expansion of port facilities.

B2.4 Catawba Island Township has the highest rate of growth for Ottawa County. The only foreseeable limiting factors to future growth are the water quality problems and a decline in beachfront properties. The population projections for the flood plain are also provided in Table B11. In Jerusalem Township, there is an actual decline in population.

b. Income Projections

B2.5 The income projections are based on the average rate of growth for (1950-1970) period and are an extension of that trend. As usual, per capita income is higher in the metropolitan regions. Although Port Clinton will experience growth in the wholesale and retail trade, the income lags behind other regions. Toledo is a support base for the Detroit automobile industry. This fact is reflected in the higher per capita income for the region as a whole.

B2.6 The Toledo SMSA is a burgeoning area in both manufacturing and the retail/wholesale industries. The numerous growth areas around the Toledo

Table B10 - Growth Sectors

County	Application Approved or Pending	Single Family	Acres	Multi-Family	Acres
Lucas					
City of Maumee	6	264	100	-	-
Township of Monclova	2	20	26	-	-
City of Oregon	14	491	159	290	35
Township of Springfield	3	208	76	61	26
City of Sylvania	13	543	182	286	38
Township of Sylvania	6	206	81	150	13
Village of Waterville	8	203	103	-	-
Village of Whitehouse	9	191	73	-	-
Wood					
Village of Northwood	7	434	118		
City of Perrysburg	12	334	225	813	
Township of Perrysburg	11	443	274		
City of Rossford	7	196	54		
Monroe					
Bedford Township	4	286	155	650	

SOURCE: Projections of Regional Growth Trends, Wallace, McHarg, Roberts and Todd Architects, October 1976, p. 28.

Table B11 - Population Projections (Growth Areas and Flood Plain)

Area	1980	1990	2000 1/	2010	2020	2030	2040
City of Toledo	371,643	371,286	377,612	378,368	379,125	379,884	380,697
City of Oregon	21,500	25,000	27,000	30,571	34,615	39,194	44,380
City of Port Clinton	7,900	8,475	9,155	9,855	10,609	11,421	12,304
City of Sylvania	18,012	20,316	19,612	20,862	22,192	23,606	25,119
City of Maumee	18,497	20,156	21,356	23,288	25,395	27,693	30,203
Township of Erie	1,489	1,508	1,528	1,548	1,568	1,588	1,608
Township of Bedford	26,156	32,774	41,066	51,450	64,460	80,760	101,192
Township of Carroll	1,400	1,500	1,596	1,699	1,809	1,926	2,052
Township of Catawba Island	3,800	5,425	7,285	10,426	14,921	21,355	30,563
Township of Danbury	3,950	5,325	6,715	8,672	11,200	14,463	18,680
Township of Portage	1,705	1,726	1,746	1,767	1,788	1,810	1,832
Township of Put-in-Bay	450	550	661	770	880	990	1,100
Township of Jerusalem	3,160	2,800	2,600	2,400	2,200	2,000	1,800
Township of Monclova	4,300	4,800	5,303	5,895	6,553	7,285	8,098
Township of Springfield	13,696	16,145	18,180	21,087	24,438	28,333	32,843
Village of Waterville	3,859	4,540	4,939	5,732	6,652	7,720	8,959
Village of Whitehouse	2,606	3,336	3,681	4,585	5,711	7,113	8,860
Township of Benton	1,980	2,006	2,032	2,058	2,084	2,110	2,137
City of Perrysburg	10,400	12,339	13,255	15,673	18,533	21,914	25,934
Township of Perrysburg	8,227	11,200	15,100	20,077	26,695	35,495	47,213
Village of Northwood	5,200	6,600	8,023	9,876	12,157	14,965	18,437

SOURCE: Local Population Forecast, Toledo Metropolitan Area Council of Governments

1/ The projections are an extension of the 1975-2000 population projection series in the Local Population Forecast.

city limits will serve as a source of population in the area. Rural areas such as the townships of Jerusalem, Carroll, and Erie will experience a more moderate rate of growth in per capita income. Income projections are given in Table B12.

c. Employment Projections

B2.7 The future for employment opportunities in the Toledo Metropolitan Area Council of Governments and the Toledo SMSA lie in the following industries: glass and concrete, transportation equipment, rubber, machinery, trucking, fabricated metals, restaurants, quarrying, department stores, health services, personal services, and amusement. Economic growth and maturity has occurred in the Toledo area due to the strong economic base and diversification of the industries. With each new basic employment position, three new local service positions are created.

B2.8 [redacted]. Continued employment growth is expected to be less than 2.5 percent. The employment projections are based on TMACOG population projections and the assumption that .429 percent of the population is employed in the work force. The growth for employment in the flood plain is centered around commercial activities. No industrial expansion is expected on the flood plain except in the city of Oregon, the Port of Toledo facilities.

B2.9 The employment opportunities for the southern shore of Lake Erie will center around Port Clinton. Areas expected to grow in residential activity will also be employment sites as supportive personal and commercial industries blossom. Employment projections are shown on Table B13.

d. Commercial Employment

B2.10 The growth in commercial employment will be centered around the developing residential areas. Personal services and retail and wholesale industries will grow to support larger population bases. The Toledo SMSA will experience growth in commercial activity. Suburban growth will increase due to population growth and a decline in Central Business District (CBD) activity. The flood plain will experience limited amounts of growth in commercial and retail activity due to fewer population growth centers. Only the city of Oregon and Catawba Township are expected to grow. Although the city of Oregon will grow, the zoning laws adopted on 1 July 1979 will restrict commercial growth to areas outside the flood plain.

B2.11 Catawba Township is expected to experience growth in the commercial services industry and the resort commercial industry. The Danbury Township is also designated a future growth area in the resort commercial industry. The growth in the resort commercial area, about 340 acres in Catawba and Danbury Townships, is not based on the forecasted distribution of population. Commercial employment projections are given in Table B14.

Table B12 - Per Capita Income Projections 1/

Area	1970	1980	1990	2000	2010	2020	2030	2040
State of Ohio	3,221	4,228	5,699	7,480	9,820	12,890	16,920	22,210
Toledo SMSA	3,408	4,562	6,107	8,175	10,940	14,645	19,605	26,245
Port Clinton	2,933	3,850	5,055	6,635	8,710	11,430	15,000	19,685
Oregon	3,618	4,860	6,550	8,830	11,900	16,040	21,560	28,980
Non-SMSA West Coast Lake Erie	3,397	4,600	6,000	8,000	10,500	13,000	17,065	22,400

SOURCE: 1970 Census of Population, U. S. Dept. of Commerce. OBERS' Projection Series E Population Regional Economic Activity in the U. S., Volume 5, p. 237 Volume 6, p. 75, U. S. Dept. of Census, 1972.

1/ Income is in 1970 dollars.

Table B13 - Employment Projections

Area	1980	1990	2000	2010	2020	2030	2040
City of Toledo	159,435 1/	159,282	161,996	162,320	162,645	162,970	163,319
City of Oregon	9,224	10,725	11,583	13,115	14,850	16,814	19,039
City of Port Clinton	3,389	3,636	3,927	4,228	4,551	4,900	5,278
Township of Erie	639	647	656	664	673	681	690
Township of Catawba Island	1,630	2,327	3,125	4,473	6,401	9,161	13,112
Township of Danbury	1,695	2,284	2,881	3,720	4,805	6,205	8,014
Township of Jerusalem	1,356	1,201	1,115	1,030	944	858	772
Township of Carroll	601	644	685	729	776	826	880
Township of Portage	731	740	744	758	767	776	786
Township of Put-in-Bay	193	236	284	330	378	425	472
City of Sylvania	7,727	8,716	8,414	8,950	9,520	10,127	10,776
Township of Springfield	5,876	6,926	7,800	9,046	10,484	12,155	14,090
Township of Monclova	1,845	2,059	2,275	2,530	2,811	3,125	3,474
Village of Waterville	1,656	1,948	2,120	2,459	2,854	3,312	3,873

1/ Assume .429 percent of Population is Employed.

SOURCE: Table B11 and Toledo Metropolitan Area Council of Governments (TMACOG) data.

Table B14 - Commercial Employment Projections

Area	1980	1990	2000	2010	2020	2030	2040
City of Toledo	45,120	45,077	45,845	45,911	46,029	46,121	46,219
City of Oregon	2,610	3,035	3,278	3,712	4,203	4,758	5,388
City of Port Clinton	959	1,029	1,111	1,197	1,288	1,387	1,494
Township of Erie	181	183	186	188	190	193	195
Township of Catawba Island	461	659	884	1,266	1,811	2,593	3,711
Township of Portage	207	209	211	215	217	220	222
Township of Danbury	480	646	815	1,053	1,360	1,756	2,268

1/ Assume 28.3 percent of Work Force Involved in Commercial Activities.

SOURCE: Table B13 and Toledo Metropolitan Area Council of Governments (TMACOG) data.

Table B15 - Manufacturing Employment by Industry,
Toledo (Thousands)

Area	Industry	1965	1966	1967	1968	1969	1970	1971	1972
Toledo	Petroleum	2.0	2.0	2.1	2.2	2.1	2.0	1.9	1.8
	Rubber	.8	1.0	1.2	.8	1.5	1.1	1.7	N.A.
	Primary Metals	6.0	7.0	6.6	6.0	6.6	5.9	5.3	5.3
	Fabricated Metals	7.1	7.5	7.1	7.3	7.6	7.1	6.3	6.2
	Machinery	8.6	9.2	9.4	9.1	9.6	9.3	8.0	8.3
	Transport Equipment	17.9	17.1	17.1	20.0	20.8	19.3	19.0	20.5

SOURCE: Economic Base Analysis 1974-2000, Toledo Metropolitan Area Council of Governments July 1977, p. 18.

e. Manufacturing Employment

B2.12 The employment by industry for the Toledo SMSA is shown in Table B15 for 1965-1972. The transportation equipment industry is the leading source of employment for the years given. The machinery industry has consistently been the second largest employer in the area. Rubber, projected to be the fastest growing sector of employment, has been sixth in historical employment. This is the major industry of Port Clinton. Erie Indutrial Park, in Erie Township, has as its major employers Uniroyal Inc. and USCO Services, Inc. Although the park has extensive employment in the rubber industry, a growing sector, leasing arrangements, and limited utility facilities will eliminate future expansion.

B2.13 Those industries related to the transportation sector are also expected to grow. The Toledo area offers future growth potential in the village of Waterville and the city of Sylvania. The city of Sylvania is an employer in the glass and concrete and health services, growth industries in the area. The village of Waterville has .68 percent of its employment concentrated in the glass and concrete industry. Potential employment areas are shown in Table B16.

f. Housing

B2.14 The basic requirement of a growing population is additional housing units. The flood plain is characterized by single family dwellings. Future housing units are based on persons per dwelling unit. For example, the city of Oregon has an average density of 3.11 persons per dwelling unit. The projection of housing units for the period 1980-2040 is shown on Table B17. The area expecting the largest rate of growth is Catawba Township. Table B18 shows the future acreage requirement to accommodate the housing units.

Table B16 - Manufacturing Employment Projections

Area	1980	1990	2000	2010	2020	2030	2040
City of Toledo	51,019 1/	50,970	51,840	51,942	52,046	52,150	52,262
City of Oregon	2,952	3,432	3,707	4,197	4,752	5,380	6,092
City of Port Clinton	1,186 2/	1,273	1,374	1,480	1,593	1,715	1,847
City of Sylvania	2,473	2,789	2,692	2,864	3,046	3,240	3,448
Township of Springfield	1,880	2,216	2,496	2,895	3,355	3,890	4,509
Township of Monclova	590	660	728	810	900	1,000	1,112
Village of Waterville	1,325 3/	1,558	1,696	1,967	2,283	2,650	3,074

1/ 32 percent of labor force is employed by manufacturing sector Lucas County .
2/ 35 percent of labor force is employed by manufacturing sector Ottawa County.
3/ 80 percent of labor force in village of Waterville is employed in manufacturing sector.

SOURCE: Economic Base Analysis 1974-2000, Toledo Metropolitan Area Council of Governments, July 1977, p. 18.
Regional Employment by Industry, 1940-1970, U. S. Dept. of Commerce, 1970 pp. 102, 105.

Table B17 - Housing Projections

Area	1990	2000	2010	2020	2030	2040
City of Oregon	1,125	643	1,148	1,300	1,472	1,668
City of Toledo	-	1,977	236	237	237	254
Township of Jerusalem	-	-	-	-	-	-
City of Port Clinton	189	224	230	248	267	290
Township of Catawba Island	521	596	1,C07	1,441	2,062	2,958
Townsip of Erie	6	6	6	6	6	6
Township of Portage	7	7	7	7	7	7
Township of Benton	7	8	8	8	8	8
Township of Carroll	31	30	32	34	37	39
Township of Danbury	430	434	612	790	1,020	1,318

1/ Assume density ratios TMACOG

SOURCE: Projections of Regional Growth Trends, Wallace, McHarg, Roberts and Todd Architects, October 1976, pp. 30-36.

Table B18 - Projected Residential Land Use [1/]

City of Oregon			
Years	Required Housing Units	Acres/Unit	Acres
1980-1990	1,125	.25	281
1990-2000	643	.25	161
2000-2010	1,148	.25	287
2010-2020	1,300	.25	325
2020-2030	1,472	.25	368
2030-2040	1,668	.25	417
Total	7,356		1,839

City of Port Clinton			
Years	Required Housing Units	Acres/Unit	Acres
1980-1990	189	.25	47
1990-2000	224	.25	56
2000-2010	230	.25	58
2010-2020	248	.25	62
2020-2030	267	.25	67
2030-2040	290	.25	73
Total	1,448		363

Township of Portage			
Years	Required Housing Units	Acres/Unit	Acres
1980-1990	7	.67	5
1990-2000	7	.67	5
2000-2010	7	.67	5
2010-2020	7	.67	5
2020-2030	7	.67	5
2030-2040	7	.67	5
Total	42		30

Table B18 - Projected Residential Land Use (Cont'd)

Township of Catawba Island			
Years	Required Housing Units	Acres/Unit	Acres
1980-1990	521	.25	130
1990-2000	596	.25	149
2000-2010	1,007	.25	252
2010-2020	1,441	.25	360
2020-2030	2,062	.25	516
2030-2040	2,958	.25	740
Total	8,585		2,147

Township of Erie			
Years	Required Housing Units	Acres/Unit	Acres
1980-1990	6	.55	3.3
1990-2000	6	.55	3.3
2000-2010	6	.55	3.3
2010-2020	6	.55	3.3
2020-2030	6	.55	3.3
2030-2040	6	.55	3.3
Total	36		19.8

Township of Benton			
Years	Required Housing Units	Acres/Unit	Acres
1980-1990	7	.90	6
1990-2000	8	.90	7
2000-2010	8	.90	7
2010-2020	8	.90	7
2020-2030	8	.90	7
2030-2040	8	.90	7
Total	47		41

Table B18 - Projected Residential Land Use (Cont'd)

Years	Required Housing Units	Acres/Unit	Acres
Township of Carroll			
1980-1990	31	.90	28
1990-2000	30	.90	27
2000-2010	32	.90	29
2010-2020	34	.90	31
2020-2030	37	.90	33
2030-2040	39	.90	35
Total	203		183

Years	Required Housing Units	Acres/Unit	Acres
Township of Danbury			
1980-1990	430	.25	108
1990-2000	434	.25	109
2000-2010	612	.25	153
2010-2020	790	.25	198
2020-2030	1,020	.25	255
2030-2040	1,318	.25	330
Total	4,604		1,153

Years	Required Housing Units	Acres/Unit	Acres
City of Toledo			
1980-1990	-	.25	-
1990-2000	1,977	.25	499
2000-2010	236	.25	59
2010-2020	237	.25	59
2020-2030	237	.25	59
2030-2040	254	.25	64
Total	2,941		740

SOURCE: Table B11, B17, Projection of Regional Growth Trends, Wallace, McHarg, Roberts and Todd Architects, October 1976, pp. 30-36.

1/ Projected acres are net acres of development per decade.

B3 - ESTIMATION OF LAND USE DEMAND

B3.1 For this study, land uses in the affected area are expected to increase for residential, commercial, industrial, and recreational use.

a. Residential

B3.2 The future housing units required to accommodate increased population in the affected area are shown in Table B18. The persons per dwelling unit is used to determine the number of units of housing needed by decade. These needs are based on density determinations of the Toledo Metropolitan Area Council of Governments (TMACOG). The existing land use for residential activity is shown in Table B18. The dwellings/person are assumed to remain unchanged throughout the planning period.

b. Commercial

B3.3 The increased land use necessary to support the larger population is based on an employees/acre by decade. The employment and commercial employment projections were used to determine the required acreage for commercial activity. The acres required per decade are shown in Table B19. The growth is expected to be limited except in Catawba Township. Recreational commercial development will absorb 340 additional acres in Catawba and Danbury Townships by 1995 to accommodate a growing demand for camping sites near the shores of Lake Erie.

c. Industrial

B3.4 Industrial growth is expected to occur in Toledo suburbs and the city of Port Clinton. According to the Ottawa County Comprehensive Development Plan, certain sites are suitable for industrial development. The land should be well drained and capable of supporting large loads without settling unevenly. Examination of soil capability maps showed the flood plain to be unsuitable for industrial development. The following characteristics are essential for industrial land use: good foundation stability (10 to 20 feet depth to bedrock), adjacent to highways, adjacent to railroads, adjacent to major utilities, adjacent to existing industry, not a flood plain, down wind from residential areas, and large relatively flat sites. Since industrial development is expected to occur in limited areas outside the Toledo SMSA, land use demands were not estimated for areas in Ottawa County. Table B15 shows growth areas in manufacturing for Lucas County. No development is expected to occur on the flood plain.

d. Recreational

B3.5 The future development of Federal and State Park facilities is limited to the Maumee Bay State Park. There are no additional plans for expansion of shoreline facilities according to the Ohio State Comprehensive Outdoor Recreation Plan (SCORP).

Table B19 - Projected Commercial Land Use 1/

Years	Commercial Employees	Employees/Acres	Acres
City of Toledo			
1980-1990	-	16.7	-
1990-2000	768	16.7	46
2000-2010	66	16.7	4
2010-2020	118	16.7	7
2020-2030	92	16.7	6
2030-2040	98	16.7	6
Total	1,142		69
City of Oregon			
1980-1990	425	16.7	25
1990-2000	243	16.7	15
2000-2010	434	16.7	26
2010-2020	491	16.7	29
2020-2030	525	16.7	31
2030-2040	630	16.7	38
Total	2,748		164
City of Port Clinton			
1980-1990	70	16.7	4
1990-2000	82	16.7	5
2000-2010	86	16.7	5
2010-2020	91	16.7	5
2020-2030	99	16.7	6
2030-2040	107	16.7	6
Total	535		31

Table B19 - Projected Commercial Land Use (Cont'd)

Years	Commercial Employees	Employees/Acres	Acres
Township of Erie			
1980-1990	2	16.7	.1
1990-2000	3	16.7	.2
2000-2010	2	16.7	.1
2010-2020	2	16.7	.1
2020-2030	3	16.7	.2
2030-2040	2	16.7	.1
Total	14		.8
Township of Catawba Island			
1980-1990	198	16.7	12
1990-2000	225	16.7	13
2000-2010	382	16.7	23
2010-2020	545	16.7	33
2020-2030	782	16.7	47
2030-2040	1,118	16.7	67
Total	3,250		195
Township of Portage			
1980-1990	2	16.7	.1
1990-2000	2	16.7	.1
2000-2010	4	16.7	.2
2010-2020	2	16.7	.1
2020-2030	3	16.7	.2
2030-2040	2	16.7	.1
Total	15		.8

Table B19 - Projected Commercial Land Use (Cont'd)

Township of Danbury			
Years	Commercial Employees	Employees/Acres	Acres
1980-1990	166	16.7	10
1990-2000	169	16.7	10
2000-2010	238	16.7	14
2010-2020	307	16.7	18
2020-2030	396	16.7	24
2030-2040	512	16.7	31
Total	1,788		107

SOURCE: Table B14, Toledo Metropolitan Area Council of Governments (TMACOG) data.

1/ Projected acres are net acres.

B4 - FLOOD PLAIN CHARACTERISTICS

a. Inherent Characteristics

(1) Recreational Facilities and Open Space

B4.1 The flood plain within the study area has many environmentally sensitive areas throughout Lucas and Ottawa Counties. Areas along the Jerusalem Township in Lucas County are basically marshes and muckland. The township is the site of the Crane Creek State Park. The State provides numerous park facilities. Many of the parks also offer winter activities at their sites. Table B20 lists the existing and proposed State Park facilities in the flood plain. Table B21 shows the wildlife reserves, both Federal and State, which exist on the flood plain. The Ottawa National Wildlife Refuge is the one of the few Bald Eagle nesting sites left on the Great Lakes. Over 250 species of birds, along with a variety of mammals, reptiles, and insects have been found on the refuge. The area is managed for waterfowl migrations and nesting.

B4.2 The flood plain also features municipal parks in the cities of Oregon, Port Clinton, and Toledo. Table B22 shows the existing sites on the flood plain. According to the Great Lakes Basin Framework Study, urban recreational needs include the improvement and construction of neighborhood parks, tot-lots, playgrounds, and community centers. The city of Port Clinton has plans for 12 new tot-lots (6 acres), better distribution of neighborhood playgrounds, and 64.4 acres of new neighborhood playground and park facilities.

(2) Wildlife

B4.3 Marsh areas along the Lake Erie shoreline provide excellent habitat for migratory waterfowl due to the abundance of food and good shelter. Many of the Lake Erie fish also spend part of their lives in marshes. The area also harbors muskrat, mink, and raccoon. Marshes in the Ottawa County region also serve as a flyway for ducks heading from eastern Canada to the wintering grounds on the Mississippi River bottoms and those ducks which winter along the Atlantic coast. Goose hunting is conducted within a 10-mile perimeter around Magee Marsh. The Lake Erie shoreline features small game including the cottontail rabbit, ring-necked pheasant, and fox squirrel. Small furbearing animals include the muskrat, mink and raccoon. Nongame wildlife of abundance include the woodchuck, red fox, and red squirrel. The only big game in the flood plain is the white-tailed deer. Rare or endangered species who make their habitat along the west Lake Erie coast are the Arctic Pelegrine Falcon, the American Bald Eagle, and the Eastern Pigeon Hawk.

B4.4 Muskrats in the northwest Ohio marshes are the reason for Ohio having the second highest muskrat harvest in the United States. Loss of any remaining habitat will reduce muskrat population and result in the incurrence of local economic losses. The Ottawa and Cedar Creek National Wildlife Refuges, about 7,921 acres, provide habitat for significant varieties of wildlife.

Table B20 - Recreational Facilities of the Flood Plain

Area	Type of Facility	Name	Acreage Existing	Additions
City of Port Clinton	Day Use	Catawba Island State Park	9	
Oak Harbor Village	Day Use	Crane Creek State Park	72	
Lakeside-Marblehead	Day Use Overnight	East Harbor State Park	1,829	
Kelley's Island	Day Use Overnight	Kelley's Island State Park	659	
Maumee Bay, east City of Oregon	Day Use Overnight	Maumee Bay State Park		1,240
South Bass Island	Day Use	South Bass Island State Park	35	

SOURCE: A Statewide Plan for Outdoor Recreation in Ohio, 1971-1977, May 1970, Ohio Dept. of Natural Resources.

Table B21 - Wildlife Reserves

Name of Area	Ownership	County	Acres	Major Activities
Cedar Point National Wildlife Refuge	United States	Lucas	2,300	
Ottawa National Wildlife Refuge	United States	Lucas/Ottawa	4,593	Hunting, natural scenery
Magee Marsh Wildlife Area	State of Ohio	Lucas/Ottawa	2,131	Fishing, hiking trails, hunting
Metzger Marsh Wildlife Area	State of Ohio	Lucas	558	Boating, fishing
Toussaint Creek Wildlife Area	State of Ohio	Ottawa	236	Boating, fishing, hunting

SOURCE: A Statewide Plan for Outdoor Recreation in Ohio, 1971-1977, May 1970, Ohio Dept. of Natural Resources.

Table B22 - Municipal Parks of the Flood Plain

Name	City	Acres	Facilities-Activities
Bay View Park	Toledo	178	Court games, field games, picnicking, play equipment
Cullen Park	Toledo	16	Boating, fishing
Detwiler Park	Toledo	219	Court games, field games, play equipment
Lakeview Park	Port Clinton	8.7	Picnicking, play area, beach, basketball, natural area
Waterworks Park	Port Clinton	14.2	Court games, field games
Danbury Park	Danbury Township	3	Fishing, picnicking, swimming
Municipal Park	Marblehead	8	Court games, field games, play equipment
Put-in-Bay Park	Village of Put-in-Bay	8	Picnicking, play equipment

SOURCE: A Statewide Plan for Outdoor Recreation in Ohio, 1971-1977, May 1970, Ohio Dept. of Natural Resources.

B4.5 The wildlife habitat in this area is being threatened by the move towards clean cultivation agriculture which results in larger equipment and larger fields with the same crop growth year after year. The use of pesticides has also reduced the number of raptorial birds in the region.

B4.6 The white-tailed deer has grown appreciably in population size due to the adoption of restrictive hunting regulations.

b. Physical Characteristics

(1) Soils

B4.7 The soil associations in the flood plain, Ottawa County, are Toledo-Fulton, Millsdale-Randolph, and marshes. The Lucas County shoreline of Lake Erie is characterized by the Latty-Toledo-Fulton, Del-Rey-Lenawee, and urban land soils.

B4.8 The Toledo-Fulton soil association is the most extensive along the Lake Erie shoreline. The Toledo soils are very dark brown, very poorly drained, and highly productive. These soils were formed in lake-laid clays and silty clay. Fulton soils are grayish-brown, somewhat poorly drained. The association is relatively treeless except for a few remaining woodlots.

B4.9 The Millsdale-Randolph association is the soil association for the Catawba Township shoreline. The dark colored Millsdale and the light colored Randolph soils are formed in glacial tills deposited over the bedrock. Millsdale soils are very poorly drained and highly productive. Randolph soils are somewhat poorly drained and moderately productive. They occur on level to depressed upland areas.

B4.10 The final Ottawa shoreline soil type is marsh soil. This soil occurs slightly below the lake level and is wet most of the year. The direction of the wind and lake levels periodically remove the surface water. The areas along the shoreline of this soil type support a marsh vegetation consisting mainly of cattails and willow. The major use of the marshes is wildlife habitat, particularly as bird refuges.

B4.11 The city of Oregon and the township of Jerusalem flood plain is dominated by the Latty-Toledo-Fulton soil association. The Latty soils are light colored and very poorly drained. Most of the soils in this association are used for farming for which they are particularly suited when artificially drained. The Del-Rey-Lenawee association is found along the Toledo shoreline. These soils are formed in loamy or clayey glacial lakebed deposits. Del Rey soils are somewhat poorly drained while Lenawee soils are very poorly drained. The land is mainly used for urban use rather than farming for which it is particularly suited.

B4.12 Urban land is located mainly within the city limits of Toledo and used mainly for nonfarm development. More than half of the urban land is occupied by buildings, streets, parking lots, railroad yards, and gas and oil

storage tanks. Table B23 summarizes the soil types and depicts their agricultural and urban land use capabilities. Some problems of the soil types are also listed.

(2) Vegetation

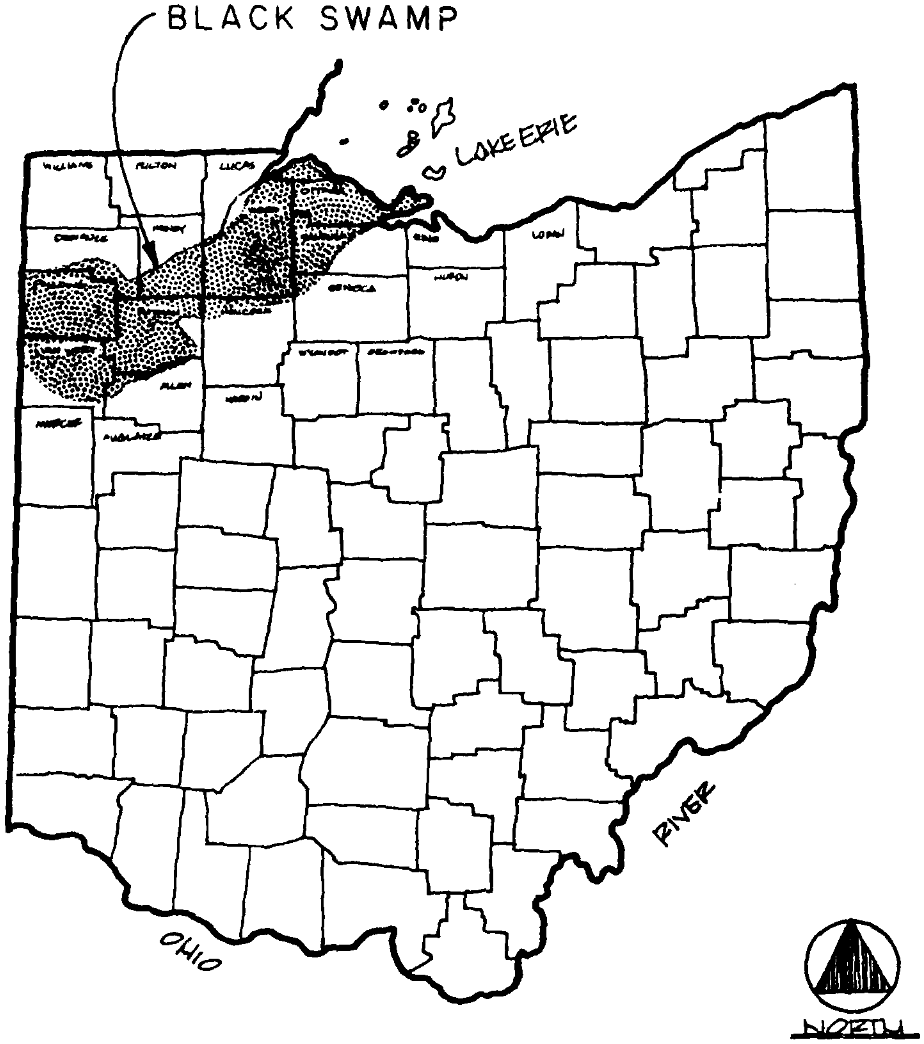
B4.13 After the last glacial period, the west coast of Lake Erie experienced a series of invasions, establishments, and replacements of different kinds of plants. The final product was a dense upland swamp forest known as the Black Swamp. As shown on Figure B1, the swamp covers the entire shoreline of Ottawa County and part of Lucas County. The swamp forests were characterized by four large plant communities: Elm-Ash Swamp forest, mixed Oak forest, Oak-Sugar Maple forest, and Beech forest. The typical tree varieties include oaks, maples, ashes, hickories, basswood, and beeches. The majority of the original forest cover has been cleared to accommodate agricultural and other types of development. Along with the development of the Black Swamp, there were extensive marshlands along the lakeshore. The marshes have also been drained and utilized in agricultural developments. The environmental uniqueness of the marshlands provides excellent habitat for rare species of aquatic plants. One marsh area of significance is Lakeview Park located east of the Port Clinton central business district. This area is being encroached by commercial development. Many southern plant species not found on the islands thrive in Lakeview Park.

B4.14 The various species of trees and plants benefit shoreline residents in a variety of ways. The roots of trees hold water, reducing the runoff rate. They also hold soil which serves as a prevention to erosion. The viscous surface of leaves traps dust particles and filters the air. The trees absorb radiation in the summer and cool the temperatures via the evaporation process.

B4.15 The most unique feature of the vegetation of the flood plain is the marshes. These freshwater wetlands provide a habitat for rare and endangered species of wildlife. Wetlands and marshes are very important to water quality in that they filter sediment and consume nutrients carried by land runoff and prevent their delivery to Lake Erie where they contribute to the problem of eutrophication. Ottawa County exhibits the largest marshland area. The Lucas County shoreline is more heavily urbanized, featuring marshy land in the vicinity of the proposed Maumee Bay State Park.

(3) Water Quality

B4.16 The extensive use of onsite sewage disposal sites in rural areas of Ottawa County results in potential health hazards to the residents. Inadequately treated septic tank effluent is discharged offsite and absorbed by the local drainage system. Local water quality officials point to the problem as follows: Septic conditions in ditches and small streams in areas where dwelling units exist on inadequate soils, and stream bacterial concentrations of fecal coliforms indicate that the problem is areawide.



THE BLACK SWAMP

FIGURE B1

Table B23 - Soil Capabilities

Soil Association	Agricultural Productivity	Limitations on Urban Land Use	Problems
Toledo-Fulton	Medium-High	Moderate-severe	- Maintenance of soil structure difficult - Septic tank systems unsuitable - Slow to moderate permeability - Low bearing strength - Both surface and subsurface drainage needed if they are to be used for building sites, roads, and to be most productive for agriculture
Millsdale-Randolph	Moderate-High	Severe	- Seasonal wetness - Low moisture holding capacity - Seasonal droughtness - Depth to bedrock 20-40 inches - Septic tank system unsuitable - Excavation of pipelines and basements difficult and expensive - Subsurface drainage is required
Marshes	Very poor	Severe	- Swampiness
Del-Rey-Lenawee	Medium-High	Moderate	- Septic tank systems unsuitable - Slow permeability - Suitable for agriculture if proper drainage - Frost action makes soil unsuitable for local roads and building sites
Urban Land	Not rated because it is about 60 percent covered by buildings, streets, and parking lots and very little soil remains unaltered.		

SOURCE: An Inventory of Ohio Soils, Lucas County, ODNR progress Report No. 52, 1977
Ottawa Comprehensive Regional Development Plan 1970-1995, 1971, pp. 64-65.

B4.17 No major streams in the Maumee River Basin contain concentrations of chlorides of sulfates exceeding 250 mg/l for each ion, the recommended limit level for drinking water established by the U. S. Public Health Service. A critical problem in the area is the low concentration of oxygen in the streams. This problem is caused by the oxygen demands of discharges from municipal waste treatment facilities.

B4.18 The highest bacterial counts are found in water immediately downstream from major communities. High bacterial counts found in water upstream of the Toledo wastewater treatment plant are caused by the Lake Erie tidal effect, which draws plant effluents upstream. Bacterial content from septic tanks is in part due to the high water tables. As the water levels rise, untreated effluent may be carried off to local drains and streams. On occasion, the cleaning of septic tanks may cause water quality problems because of the inadequate disposal of solid wastes and liquid. The counties of Lucas and Ottawa do have provisions for the disposal of septic tank wastes in septic treatment plants but the enforcement of this disposage type is not enforced. There are no provisions made for the proper maintenance of septic tanks that is necessary to insure water quality.

(4) Mineral Resources

B4.19 The study area has limited petroleum and natural gas reserves. Sand and gravel deposits are found along the entire flood plain. Dredging of submerged deposits, as in the Maumee Estuary, serves as an important source of sand and gravel in this part of Ohio. The output is used mainly in building and road construction. Not only are sand and gravel important in commercial use, they are also useful in the natural beach nourishment process for recreational areas. Lake-related sand and gravel deposits vary considerably in their composition. The lake deposits range from the fine, well sorted sands offshore of Cedar Point National Wildlife Refuge to moderately well sorted sands in Maumee Bay.

B4.20 Clay and peat deposits are also found in the flood plain. Clay is used in the manufacture of cement and common clay products. Peat is used primarily for soil improvements. As a whole, clay and peat are insignificant resources in the flood plain. The value lies in the sand and gravel production.

B4.21 Surface quarries at Marblehead yield sandstone, a resource which yields a higher dollar value than the equivalent short tonnage of sand and gravel. Plate B2 shows the resources in the flood plain.

c. Available Services

(1) Transportation

(a) Highways

B4.22 The flood plain is not serviced by major highway facilities other than State Routes 2 and 53. State Route 2, a four-lane highway, provides a

ready access to U. S. Interstate 80-90 and U. S. 20. County and township roads are in excellent shape. The highway transportation problem lies in the bridges crossing the numerous streams and creeks traversing the flood plain. The bridge and road repairs cannot keep pace with the current construction costs and inflation. At present, efforts are being made to improve the State of Ohio's method of financing bridge and road repair.

B4.23 The overall location of roads is a gridiron pattern at 1-mile intervals along range and section lines. The road orientation is north-south and east-west. Of course, the exception to this is a portion of State Route 2 which runs diagonally through Erie and Carroll Townships.

B4.24 The construction of roads follows typical cross section dimensions for right-of-way and pavement widths. The basic pattern is shown in Table B24.

Table B24 - Highway Patterns

	Widths (Feet)	
Route Type	Right-of-way	Pavement
Primary	60-100	24-28
Secondary	50-80	20-24

SOURCE: Ottawa Comprehensive Regional Development Plan 1970-1995, 1971, p. 181.

(b) Rail Transportation

B4.25 The city of Toledo is the hub of the railroad activity in the flood plain. Seven major railroad lines converge at the city of Toledo including the Toledo, Angola, and Western Railway Company, the Wheeling and Lake Erie Railway Company, the Wabash Railroad Company, the Pennsylvania Railroad Company, the Norfolk and Western Railroad Company, the Chesapeake and Ohio Railway Company, and the Baltimore and Ohio Railroad Company.

B4.26 The flood plain in Ottawa County is located on the main line of the Conrail, formerly the New York Central Railroad and the Norfolk and Western Railroad. These two lines have connecting truck service on a daily basis for both interstate and intrastate shipments. Railroads provide economical passenger and bulk freight service to the flood plain.

B4.27 According to a 1975 industrial transportation survey conducted in the Toledo Urbanizing Area, 13 percent of larger manufacturing firms found the transportation facilities to be inadequate. One of the problems is the lack of good connections with the Port of Toledo water transportation facilities.

(c) Water Transportation

B4.28 The Port of Toledo is a vital link in the State's transportation system. The port facilities, 23rd largest in the United States, contribute to the local economy and attract shipping-related industries into the coastal zone as well as providing a port of entry and exit for grain, coal, iron ore, and paper. The two major shipping commodities are coal and iron ore. Over 23,275,700 short tons of cargo passed through the Port of Toledo in 1977. Inbound cargo totaled 5,149,068 short tons and outbound traffic amounted to 18,126,639 short tons. The shipping season for the port facilities extends from 1 March to 31 December. Two other smaller harbors exist on the flood plain including the Port Clinton Harbor and the Put-in-Bay Harbor which had 1977 short tonnage totals of 19,492 and 6,089, respectively. Port Clinton Harbor's major commodity is sand, gravel, and crushed rock. In order for industrial development to exist and be sustained, it is necessary for the transportation facilities to be adequate. A recent survey in the Toledo SMSA area indicated that the majority of manufacturers are satisfied with the water transportation facilities.

(2) Water Facilities

B4.29 The city of Port Clinton has its own water treatment plant which services Oak Harbor, portions of Erie Township, and portions of Portage Township. The source of water is Lake Erie. Water is pumped via a 30-inch pipe in Lake Erie some 3,000 feet to the inland area. The plant has a full capacity of 3.0 million gallons per day (mgd) with summer season usage of 1.76 mgd and winter usage of 1.42 mgd. A 500,000 gallon elevated tank and a 500,000 gallon clear well act as storage facilities and help to maintain an even pressure throughout the system. The treatment at the Port Clinton facility includes purification, chemical dosage for softening, disinfection, filtration, chemical stabilization, sedimentation, and chemical taste and odor control. The facility is shown on Plate B3.

B4.30 The flood plain is also serviced by private water treatment facilities. The major private water facility is at the Erie Industrial Park. Plant capacity is 870,000 gallons per day. Pressure on the system is maintained by usage of a 100,000 gallon elevated tank. Two reservoirs have a combined storage capability of 1,200,000 gallons of water. Another private water supply system services the Camp Perry Military Installation. Plant capacity is 1.0 mgd at this site. The Camp Perry and Erie Industrial Park have interconnected water mains for emergency purposes only. Plate B4 depicts the water treatment facility at Camp Perry.

B4.31 There is one water treatment plant servicing the city of Oregon and vicinity located in the township of Jerusalem. The capacity design is 8 mgd and average capacity is 5 mgd. There is one intake crib located a mile out in Lake Erie. The diameter of the pipelines varies from 6 to 48 inches. There is also one high level generating pumping station located near the Lake Erie shoreline at the site of the intake crib. The plant is located 1 mile from the Lake Erie shoreline.

B4.32 The Toledo water treatment plant located in Cullen Park, as shown on Plate B5, has a 120 mgd capacity. The average water intake is 82 mgd. The facility has six generating pumps and receives water via an intake crib in Lake Erie. Water lines vary in diameter from 4 to 48 inches. This is the largest water treatment facility in the study area and services the entire Toledo SMSA. High water levels would definitely help the water treatment plants.

(3) Sanitary Sewer Facilities

B4.33 The flood plain in Ottawa County is serviced by two sanitary sewerage facilities. The Port Clinton sewerage system consists of sanitary and combined sewers. The diameter of the sewers vary from 8 to 48 inches. There are two trunk lines, 30 inches and 48 inches, with the 48-inch line being a combined sewer. During periods of heavy rainfall and flooding, all of the flow from the combined sewer can be diverted into a storm water pumping station. The Port Clinton sewage system, portrayed on Plate B6, utilizes four pumping stations in conjunction with gravity sewers. Peak daily flow is 1.5 mgd with a plant capacity of 3.1 mgd. The facility is at present experiencing problems with heavy infiltration flows. The area also faces considerable difficulty due to onsite sewage disposal facilities.

B4.34 As a response to the Erie Industrial Park, there was a private sewer system developed to meet the industrial needs. The sewer sizes vary from 6 to 12 inches in diameter with three pumping stations. The treatment plant is capable of primary and secondary treatment. Another private sanitary sewerage facility services the Camp Perry Military Installation. The installation has two pumping stations fed by sewer lines 8 to 15 inches in diameter. The total capacity of this facility is 1.0 mgd. These private facilities are shown on Plate B7. None of the facilities servicing the Ottawa flood plain are at full capacity. The growth area of Catawba and Danbury Townships is the site of a new sewerage facility to meet future growth demands.

B4.35 The city of Oregon is serviced by two sewerage treatment plants. The largest plant is located at South Shore Park, shown on Plate B8, within the city limits. The plant capacity is 225,000 gpd and the sewage lines vary in diameter from 6 to 60 inches. The plant services the entire city and some outlying villages and towns. There is also a sludge treatment plant near Maumee Bay with an 8,000,000 gpd capacity. The plants are regional and provide sanitary sewerage services for urban and rural areas.

B4.36 The city of Toledo sewerage treatment plant is located on the bank of the Maumee River at Bayview Park. The plant has a 125 mgd capacity and averages 100 mgd. The diameter of sanitary sewer lines varies from 8 to 84 inches, depending on type and location. This wastewater treatment plant, shown on Plate B9, services the entire city of Toledo and vicinity.

B5 - PROJECTION OF LAND USE IN THE FLOOD PLAIN

a. Introduction

B5.1 Table B25 shows existing land uses in the flood plains of the city of Port Clinton and the city of Oregon. According to the Toledo Metropolitan Area Council of Governments (TMACOG), there is not expected to be any future shoreline development in the flood plain zones. The future flood plain development is limited to the industrial expansion of oil tank facilities on the bank of the Maumee River in the city of Oregon, near Toledo.

b. Residential

B5.2 The city of Oregon, located directly east of the city of Toledo, has a total of 403 residential structures in the flood plain, 215 of which would be affected by the 100-year flood level. Residential development to accommodate the growing population will occur on sites off the flood plain. Development is expected to occur west of Bayshore Road on existing vacant and agricultural land. Jerusalem Township will experience residential development in the Reno Beach-Howard Farms area and the far western portion of the township between Seaman and Brown Roads. Benton Township residential activity will expand in the southeast of Rocky Ridge west of Lickert-Harder Road on Route 22, south of Penn Central Railroad and north of La Carpe Creek. Carroll Township anticipates the development of 21 acres of residential land in a dispersed pattern.

B5.3 Erie Township will have residential development in the area between State Route 2 and 163, east of State Route 358. The city of Port Clinton is not expected to experience any development in residential activity on the flood plain. The city contains 1,284 homes on the flood plain, 675 of which are affected by the 100-year flood level. Portage Township residential development is expected to occur south of State Route 2 bypass, east of Sloan Road. Catawba Island Township residential growth will occur west of State Route 53, east of County Road 30, and north of Cemetery Road. Danbury Township residential development will take place south of State Route 163, east of Church Road, and west of Englebeck Road.

c. Commercial

B5.4 Commercial expansion will take place in sites off the flood plain. Additional service commercial facilities are needed for the West Coast Lake Erie study area in the following locations: in Portage Township south of bypass State Route 2, west of Sloan Road, and in the extreme northwest corner of Danbury Township at the intersection of State Route 163 and Danbury Road. Each of the proposed sites would allow for the development of a 36-acre complex, serving the needs of year-round residents in the county. The locations relate to proposed new housing concentrations and utility facilities. Resort commercial development is proposed for Catawba Island Township in the vicinity of West Harbor and Danbury Township along East Harbor. Each of the proposed sites comprises 170 acres.

Table B25 - Land Use Within the Intermediate and Standard Project Flood Zones (Acres)

Land Use Activity	IRF	SPF
City of Oregon		
Recreational	406	620
Residential	172	192
Agricultural	26	79
Vacant	65	65
Public and Other	6	6
Total	675	962
City of Port Clinton		
Residential	204	285
Recreational	58	72
Commercial	67	113
Industrial	-	69
Public and Other	18	38
Vacant	85	85
Water	162	263
Deciduous Forest Land	27	27
Total	621	952

d. Public and Other

B5.5 The flood plain is the site of the Port Clinton wastewater and water treatment plants. The existing land use patterns for public utility and transportation facilities are included in the existing activity tables of the cities of Port Clinton and Oregon. The only proposed public sites are the nuclear energy plants at the Bessemer Davis plant and the proposed sewerage treatment facility in Danbury Township to service the growth areas of Catawba Township and Danbury Township.

e. Agriculture

B5.6 The city of Oregon, in its 1 July 1979 zoning laws designated large tracts of land throughout the city as agricultural sites. This is an effort to preserve agricultural land in incorporated communities. However, rural zoning in a city may be too restrictive. The courts have ruled that it is unconstitutional to preserve agricultural land at the expense of allowing the building of needed low and moderate income housing. It is thus reasonable to assume that some of the zoned agricultural land will give way to residential development during the project life.

f. Open Space

B5.7 A large amount of the flood plain in the city of Oregon is concentrated in open space and recreational land. The Maumee Bay State Park will occupy 660 acres in the flood plain. Both Lakeview Park and Waterwork Parks on the Port Clinton shoreline are in the flood plain and consist of 22.9 acres. The city of Port Clinton has no plans to expand these two municipal parks. The future development of Federal and State Park facilities is limited to the Maumee Bay State Park according to the Ohio State Comprehensive Outdoor Recreation Plan (SCORP).

B6 - DAMAGES UNDER EXISTING CONDITIONS

a. Damage Survey

B6.1 In the summer of 1979, the Buffalo District conducted a damage survey for the West Coast Lake Erie study. The damages were determined for residential and public and other for the city of Oregon and residential, commercial, and public and other for Port Clinton. The residential damages were determined for lake level damages with and without waves. The examination of damages with waves includes wave runup caused by the waves rushing up the beach or structure. It was assumed that only first tier houses along the immediate shoreline would be affected by waves. The city of Oregon damages survey consisted of 403 residential units, of which 326 were included in the without waves damages and 77 were included in the with waves damages for the city of Oregon. The city of Port Clinton has a total of 1,054 residential units in the without waves category and 230 in the with waves category for a total of 1,284 units in the damages survey. The commercial damages survey was limited to the city of Port Clinton since there were no commercial units in the flood plain in the city of Oregon. A total of 100 commercial units were included in the Port Clinton commercial damages survey. The public and other damages were determined through city records of past flood damages. The records contained in the Oregon and Port Clinton city halls for past floods were utilized to derive stage-damage curves for public and other damages. Table B26 summarizes the damages for various flood occurrences in the cities of Oregon and Port Clinton for waves and without waves for residential, commercial, and public and other categories. A similar survey was conducted at Sand Beach, Long Beach, Locust Point in Carroll Township in February 1981. The structures within the 100-year flood plain are shown in Table B27 for the areas surveyed.

b. Reach Limits

B6.2 The location of each area evaluated for damages, agricultural reaches, and the initial damage elevation are presented in Table B28.

c. Methodology

B6.3 A stage-damage relationship was developed for the cities of Port Clinton and Oregon, and Locust Point, Long Beach, and Sand Beach in Carroll Township. Table B29 displays the stage-damage relationship by structure and contents. The residential and public and other activities were included in the stage-damage relationship developed for the city of Oregon. Residential, commercial, and public and other activities were evaluated for the stage-damage relationship in the city of Port Clinton. Residential damages were determined for Locust Point, Long Beach, and Sand Beach in Carroll Township. Damages shown in Table B30 were determined by the following methods:

(1) Residential

B6.4 The first floor elevation, value of structure, and type of house were determined based on field observations. The value of the typical structure on the flood plain is based on the current real estate value. Damages

Table B26 - Estimated Damages for Various Flood Occurrences
August 1979 Price Levels and Conditions of Employment

Recent Chance of Occurrence	Return Interval in Years	Stage (IGLD) Reach Z	Stage (IGLD) Reach X	Reach Z City of Oregon	Reach X City of Port Clinton
		$	$	$	$
Total Residential Damages/Waves					
0.2	500	579.34	578.80	473,000	1,536,700
0.5	200	578.80	578.22	375,000	1,170,000
1.0	100	578.36	577.80	299,000	910,000
2.0	50	577.90	577.31	226,000	644,000
4.0	25	577.37	576.80	147,000	394,000
5.0	20	577.19	576.60	130,000	320,000
10.0	10	576.56	575.97	60,000	161,000
20.0	5	575.80	575.18	17,000	49,000
50.0	2	574.34	573.70	0	6,700
Total Residential Damages/Without Waves					
0.2	500	577.10	576.70	661,100	244,400
0.5	200	576.71	576.32	441,000	152,000
1.0	100	576.40	576.00	314,000	96,000
2.0	50	576.06	575.68	218,000	55,000
4.0	25	575.69	575.30	130,000	25,500
5.0	20	575.55	575.14	101,000	17,100
10.0	10	575.11	574.70	48,000	6,000
20.0	5	574.58	574.13	22,000	500
50.0	2	-	573.06	5,000	0

Table B26 - Estimated Damages for Various Flood Occurrences
August 1979 Price Levels and Conditions of Employment (Cont'd)

Recent Chance of Occurrence	Return Interval in Years	Stage (IGLD) Reach Z	Stage (IGLD) Reach X	Reach Z City of Oregon	Reach X City of Port Clinton
		$	$	$	$
Total Commercial Damages/Waves					
0.2	500	579.34	578.80		1,840,000
0.5	200	578.80	578.22		1,330,000
1.0	100	578.36	577.80		990,000
2.0	50	577.90	577.31		654,000
4.0	25	577.37	576.80		390,000
5.0	20	577.19	576.60		291,000
10.0	10	576.56	575.97		163,000
20.0	5	575.80	575.18		64,000
50.0	2	574.34	573.70		0
Total Commercial Damages/Without Waves					
0.2	500	577.10	576.70		59,500
0.5	200	576.71	576.32		34,700
1.0	100	576.40	576.00		19,500
2.0	50	576.06	575.68		8,500
4.0	25	575.69	575.30		1,000
5.0	20	575.55	575.14		600
10.0	10	575.11	574.70		0
20.0	5	574.58	574.13		0
50.0	2	-	573.06		0

Table B26 - Estimated Damages for Various Flood Occurrences
August 1979 Price Levels and Conditions of Employment (Cont'd)

Recent Chance of Occurrence	Return Interval in Years	Stage (IGLD) Reach Z	Stage (IGLD) Reach X	Reach Z City of Oregon	Reach X City of Port Clinton
		$	$	$	$
Total Public and Other Damages					
0.2	500	577.10	576.70	81,900	59,600
0.5	200	576.71	576.32	68,700	45,200
1.0	100	576.40	576.00	57,000	34,400
2.0	50	576.06	575.68	45,300	23,500
4.0	25	575.69	575.30	31,800	14,800
5.0	20	575.55	575.14	26,400	11,700
10.0	10	575.11	574.70	13,000	5,200
20.0	5	574.58	574.13	0	2,000
50.0	2	-	573.06	0	0

Table B27 - Structures Within the 100-Year Flood Plain

Area	Number of Structures: Residential	Number of Structures: Commercial	Average First Floor Elevation of Structures
Oregon	215	3	577.5
Port Clinton	675	90	577.4
Long Beach	115	-	576.6
Sand Beach	100	-	577.3
Locust Point	130	3	576.3

Table B28 - Damage Reaches

Reach	Location	Initial Damaging Elevation IGLD)	Recurrence Interval In Years	Limits of Reach
	Oregon	574.0	3.0	Along shoreline from Harbor View to Norden Road, Oregon
	Locust Point	573.0	2.0	Along Township Route 237 south of canal to Turtle Creek Bay, Carroll Township
	Long Beach	572.5	1.5	Along Hollywood Street and Long Beach Road, Carroll Township
	Sand Beach	573.0	2.0	Along Division Street, Carroll Township
	Port Clinton	571.0	1.25	5,000 feet west of Port Clinton city line to 3,200 feet northeast of the Portage-Catawba Island town line
Z	Oregon	572.0	1.2	Along shoreline from Harbor View to Cedar Point, Jerusalem Township
Y	Lucas County Ottawa County	572.0	1.25	Cedar Point, Jerusalem Township to Locust Point, Carroll Township
X	Port Clinton	572.4	1.4	Locust Point, Carroll Township to Marblehead, Danbury Township

Table B29 - Structural and Contents Damages in Percent

	Structural Damages in Percent				
Depth	1N 1/	2N 2/	1B 3/	2B 4/	3B 5/
- 8.0	0.0	0.0	0.0	0.0	0.0
- 7.0	0.0	0.0	2.0	0.8	0.8
- 6.0	0.0	0.0	3.4	1.2	1.2
- 5.0	0.0	0.0	4.8	1.6	1.6
- 4.0	0.0	0.0	5.6	1.9	1.9
- 3.0	0.0	0.0	6.2	2.1	2.1
- 2.0	0.0	0.0	6.8	3.3	6.1
- 1.0	2.0	2.0	7.5	5.1	9.8
0.0	5.8	4.6	10.0	8.0	13.7
1.0	13.2	8.5	17.0	11.3	19.0
2.0	23.0	14.5	22.3	17.0	26.0
3.0	31.0	21.6	25.8	25.0	36.5
4.0	38.2	27.5	39.0	35.0	52.0
5.0	50.0	38.0	64.0	50.0	74.0
6.0	66.0	58.0	78.0	70.0	82.5
7.0	82.0	78.0	87.0	84.0	90.0
8.0	92.0	90.5	94.0	93.0	95.0
9.0	100.0	100.0	100.0	100.0	100.0

Table B29 - Structural and Contents Damages in Percent (Cont'd)

Depth	Contents Damages in Percent				
	1N 1/	2N 2/	1B 3/	2B 4/	3B 5/
-8.0	0.0	0.0	0.0	0.0	0.0
-7.0	0.0	0.0	5.0	2.9	1.3
-6.0	0.0	0.0	8.3	4.7	1.9
-5.0	0.0	0.0	11.0	6.0	3.1
-4.0	0.0	0.0	12.7	7.0	5.1
-3.0	0.0	0.0	14.0	8.0	7.8
-2.0	0.0	0.0	15.0	8.8	11.0
-1.0	0.0	0.0	17.0	9.7	14.9
0.0	17.0	5.5	23.7	13.5	19.2
1.0	37.5	19.0	34.9	19.3	24.3
2.0	56.0	29.0	49.6	28.2	30.7
3.0	68.0	37.0	61.3	37.2	37.0
4.0	75.2	43.7	68.0	44.5	43.9
5.0	80.1	49.7	72.2	50.5	51.0
6.0	83.8	57.3	77.9	57.9	58.3
7.0	87.6	64.9	83.6	65.3	65.5
8.0	91.3	72.4	89.3	72.6	72.8
9.0	95.0	80.0	95.0	80.0	80.0

1/ One story, no basement.
2/ Two story, no basement.
3/ One story, with basement.
4/ Two story, with basement.
5/ Split level.

were calculated at various flood depths based on depth-percent damage relationships. The initial damage elevation was defined as the flood height at which water entered the unit's lowest opening. Damages to the units were based on cost of repair, the depreciated value or cost of replacement.

(2) Commercial

B6.5 The damages incurred during flooding were estimated on the basis of interviews with owners and/or managers of commercial establishments on the flood plain. The estimate of damages includes damages to machinery and inventory, lost production time, damages to structures, and anticipated cleanup costs. The field personnel also documented the overall condition of the building and equipment, as well as the type and value of inventory.

(3) Public and Other

B6.6 The damages to public buildings, local roads, bridges, and utilities were included in the damages to public and other. Emergency flooding operations and cleanup costs incurred by local, State, and Federal agencies are also included in the damage estimates for public and other. For the cities of Oregon and Port Clinton, damages were obtained from the official damages sustained during recent floods.

(4) Agricultural

B6.7 The agricultural damages are based on an examination of existing agricultural production in the flood plain. Crop acreage for Lucas and Ottawa Counties, Ohio by reach is shown in Table B31. The agricultural reaches for the West Coast Lake Erie study are derived from the open coast reaches as given in the "Report on Great Lakes Open-Coast Flood Levels" of the Detroit District, dated February 1977. The agricultural reaches are identified as X, Y, and Z in the 1977 report. Reach Z includes the area of the city of Oregon through Cedar Point and lies within Lucas County. Reach Y encompasses Cedar Point through Locust Point and lies within Lucas and Ottawa Counties. Reach X includes the land area from Locust Point to Marblehead and lies within Ottawa County. An area description is shown on Plate B10.

B6.8 The initial step in determining total average annual crop damage was to establish the gross revenue per acre of cropland. The term cropland in this report refers to the total acreage in crop usage according to the Ohio Department of Natural Resources land-use maps developed by aerial photography. The land-use maps were planimetered to determine total cropland in the flood plain. Cropland, in terms of row crops and field crops, were identified on the computerized maps. Average yield per acre is based on the soil association for Lucas and Ottawa Counties: Toledo-Fulton. The yield estimates for the Toledo-Fulton association appear in the Inventory of Ohio Soils, Ohio Department of Natural Resources Division of Land and Soil, 1977. Crop yields in the flood plain are shown on Table B32. Normalized prices for crops grown in the flood plain were obtained from "Info Memo" published by the U. S. Water Resources Council, Washington, DC, June 1980. Crop prices in the flood plain are shown in Table B33. The gross revenue is determined by multiplying the crop yield by the crop normalized price. The gross revenue

Table B30 - Estimated Average Annual Damages, January 1981 Price Levels

Area	Residential	Commercial	Public and Other	Agricultural	Total
	$	$	$	$	$
City of Oregon	28,200	0	2,400	0	30,600
Locust Point	26,100	0	0	0	26,100
Long Beach	34,600	0	0	0	34,600
Sand Beach	28,600	0	0	0	28,600
City of Port Clinton	93,700	74,100	4,000	0	171,800
W. Lake Erie Shore	211,200	74,100	6,400	705,800	997,500

Table B31 - Acres of Cropland in the Flood Plain by Reach

Reach	10-Year	IRF	SPF
Z	720	1,200	1,460
Y	6,870	8,740	9,810
X	2,840	4,200	6,030
Total	10,430	14,140	17,300

per acre for soybeans is $240 which is 38 bushels per acre multiplied by the unit price of $6.31 per bushel.

B6.9 The maximum adjusted potential loss per acre of cropland is determined by multiplying the seasonal adjustment factor by the gross revenue per acre of cropland. The seasonal adjustment factor for each crop is developed in Table B34. The seasonal adjustment factor was derived for application of annual stage-frequency curves. Monthly stage-frequency curves were not available for this level of study. The seasonal adjustment method spreads the potential agricultural loss over a 12-month period. The seasonal adjustment factor method indicates that there is an equal probability of flooding for any given month. The assumption of equal probability flooding results in higher average annual damages for agriculture than with the use of monthly stage-frequency curves. This method ignores the effect of flood duration and velocity on crop damages and also simplifies the analysis. Recurring events within a single growing season are not evaluated with annual stage-frequency curves. However, with monthly curves, the probability of several floods in one growing season must be considered. The residual damages were not calculated in this level of study since the magnitude of the potential benefits is very low compared to project costs and the project does not appear to be economically feasible even with residual damage effects excluded from the analysis. For soybeans, the growing season is May through November. The length of the growing season for crops in the flood plain were determined via conversations with Doyle Summer, an agent with the Soil Conservation Service in Ottawa County, and Diana Holt of the Lucas County Soil Conservation Service. The soybean crop is in the ground 7 months, therefore the seasonal adjustment factor is 7/12 of .5833. Table B35 shows the calculation of the potential agricultural loss for the Intermediate Range Flood (IRF) in reach Y. The maximum adjusted potential loss for soybeans is $140 or $240 gross revenue multiplied by the appropriate seasonal adjustment factor, .5833. Reach summaries are shown in Table B36. The potential agricultural loss is determined by multiplying the maximum adjusted potential loss per acre by crop by the total acres devoted to that crop. The crop distribution is based on the assumption that the flood plain crop distribution is the same as the county-wide crop production patterns. There are 1,460 acres in agricultural activity in reach Z. Reach Z lies entirely within Lucas County and the crop distribution is based on Lucas County as given in the Ohio Agricultural Statistics, May 1980 compiled by the Ohio Crop Reporting Service. The crop distribution in reach Z is 53 percent soybeans, 29 percent corn, 13 percent wheat, 4 percent hay, and 1 percent sugar beets. Reach Y has a total crop acreage of 9,810 in reach Y, 77 percent or 7,554 acres lie within Lucas County and 23 percent, or 2,256 acres lie within Ottawa County. The crop distribution of 6,030 acres in reach Y is 53 percent soybeans, 27 percent corn, 14 percent wheat, 5 percent hay, and 1 percent sugar beets. The crop distribution in reach X is 54 percent soybeans, 17 percent corn, 16 percent wheat, 8 percent hay, 3 percent oats, and 2 percent sugar beets based on the Ottawa County crop distribution in the Ohio Agricultural Statistics, May 1980 compiled by the Ohio Crop Reporting Service.

Table B32 - Crop Yields in the Flood Plain

Crop	Yield/Acre
Corn	120 bushels
Hay	2.5 tons
Oats	50 bushels
Soybeans	38 bushels
Sugar Beets	20 tons
Wheat	120 bushels

SOURCE: An Inventory of Ohio Soils, Ohio Department of Natural Resources, Division of Lands and Soils, 1977.

Table B33 - Crop Prices in the Flood Plain 1/

Crop	Normalized Price
	$
Corn	2.14 bushel
Hay	51.76 ton
Oats	1.32 bushel
Soybeans	6.31 bushel
Sugar Beets	27.14 ton
Wheat	2.74 bushel

1/ Based on 1980 normalized prices published by the U. S. Water Resources Council.

Table B34 - Derivation of Seasonal Adjustment Factor

Crop/Month	Months in Ground by Crop												Total Number of Months	Weighted Factor
	JAN	FEB	MAR	APR	MAY	JUNE	JUL	AUG	SEP	OCT	NOV	DEC		
Corn					X	X	X	X	X	X	X		7	7/12 = .5833
Hay			X	X	X	X	X	X	X	X			8	8/12 = .6667
Oats			X	X	X	X							4	4/12 = .3333
Soybeans					X	X	X	X	X	X	X		7	7/12 = .5833
Sugar Beets					X	X	X	X	X	X	X		7	7/12 = .5833
Wheat	X	X	X	X	X	X				X	X	X	9	9/12 = .7500

Table B35 - Calculation of Potential Agricultural Loss

Reach Y Stage 576.2

Crop	(1) Acres	(2) Percent Crop Distribution of Acres 1/	(3) Crop Yield by Acre	(4) Unit Price	(5) Gross Revenue Per Acre	(6) Seasonality Factor	(7) Maximum Adjusted Potential Loss	(8) Potential Agricultural Loss
				$	$ (3)X(4)=(5)		$ (5)X(6)=(7)	$ (1)X(7)=(8)
Soybeans	4,630	53	38 bu.	6.31	240	.5833	140	648,200
Corn	2,360	27	120 bu.	2.14	257	.5833	150	354,000
Wheat	1,220	14	45 bu.	2.74	123	.7500	92	112,240
Hay	440	5	2.5 tons	51.76	181	.6667	121	53,240
Sugar Beets	90	1	20 tons	27.14	543	.5833	317	28,530
	8,740	100						1,196,210

1/ SOURCE: Ohio Agricultural Statistics, May 1980, Ohio Crop Reporting Service.

Table B36 - Potential Agricultural Loss in Reaches Z, Y, and X

Reach Z		
Stage	Agricultural Area (Acres)	Potential Agricultural Loss
		$
572.0	0	0
575.1	720	99,105
576.4	1,200	165,030
577.1	1,460	200,500

Reach Y		
Stage	Agricultural Area (Acres)	Potential Agricultural Loss
		$
572.0	0	0
574.9	6,870	940,250
576.2	8,740	1,196,210
576.9	9,810	1,342,530

Reach X		
Stage	Agricultural Area (Acres)	Potential Agricultural Loss
		$
572.4	0	0
574.8	2,840	376,430
576.0	4,200	555,300
576.7	6,030	799,300

B6.10 Table B35 shows the stage damages for agricultural for reach Y at stage 576.2, the IGLD elevation of the 100-year flood event. The potential agricultural loss for soybeans is $648,200 or 4,630 acres multiplied by the maximum adjusted potential loss per acre for soybeans, $140. The total potential agricultural loss for reach Y, stage 576.2, is $1,196,210 as shown on Tables B35 and B36. The potential agricultural loss for reaches X, Y, and Z is shown for each stage on Table B36.

B6.11 Damage-frequency curves were developed for each reach from the stage-frequency curves shown in Plates B11-B13 and the stage-damage relationships shown in Table B36. The area under each damage-frequency curve shown in Plates B14-B16 represents the average annual crop damage due to flooding. The average annual damages under existing conditions, 1980 price levels were determined by using the Hydrologic Engineering Center's computer program L2510. The average annual damages, based on June 1980, prices are presented in Table B37.

d. <u>Stage-Damage Relationship</u>

B6.12 The expected damages at various stages were developed by the Buffalo District's Hydraulic Analysis Section. These damages are based on stages at the appropriate gage on Lake Erie. The damages for the city of Oregon are based on the Toledo gage. The damages for Locust Point, Sand Beach, Long Beach, and the city of Port Clinton are based on the Marblehead gage. The elevation for zero damages in each reach was based on data obtained from interviews and field observations. These points were then used to develop stage-damage curves for each activity in each reach and are shown on Plates B17-B23. These stage-damage curves are based on August 1979 price levels and conditions of development in the city of Port Clinton and Oregon and February 1981 conditions of development in Locust Point, Sand Beach, and Long Beach.

e. <u>Stage-Frequency Relationship</u>

B6.13 The stage-frequency curves show the likelihood of a certain stage or flood level occurring expressed in terms of probability. The stage-frequency curves for Lake Erie at Oregon, Port Clinton, Sand Beach, Long Beach, and Locust Point were developed from the "Report on Great Lakes Open-Coast Flood Levels" of the Detroit District, dated February 1977. The stage-frequency curves are shown on Plates B11-B13.

B6.14 Wave heights for various Lake Erie water levels were established. It was assumed that only first tier homes along the immediate shoreline would be affected by waves. Although the first tier homes along the immediate shoreline generally are situated on high ground, additional damages are incurred from wind-driven waves and flood water flowing inland.

Table B37 - Average Annual Agricultural Damages

Reach	Average Annual Damages
	$
X	163,100
Y	499,340
Z	43,330
Total	705,770

B7 - AVERAGE ANNUAL DAMAGES

B7.1 The average annual damages for August 1979 conditions of development for Port Clinton and Oregon and February 1981 conditions of development for Locust Point, Long Point, and Sand Point in Carroll Township and January 1981 price levels, are given in Table B30. The existing damages for the city of Oregon include residential and public and other. The damages for the city of Port Clinton include residential, commercial, and public and other. The rural areas of Locust Point, Long Point, and Sand Beach have average annual residential damages. The agricultural damages were determined for the Western Lake Erie Shore from the city of Oregon in Lucas County to Marblehead in Ottawa County and are summarized in Table B30.

B8- BENEFITS

a. Flood Inundation Reduction Benefits

B8.1 The flood inundation reduction benefits ar the difference between the expected value of damages with and without the project. The residual damages were not calculated for all the plans since the magnitude of benefits is very low and the proposed plans do not appear to be economically feasible even with residual damages effects excluded from the analysis. The nonstructural plan for the city of Oregon will result in over 60 percent of the residential properties realizing no flood damages. The residual damages were estimated to be $6,000 for Plan 2 of the city of Oregon. The flood inundation reduction benefits are $30,600 for the dike alternative and $24,600 for the nonstructural alternative for the city of Oregon. The Locust Point, Long Beach, and Sand Beach areas of Carroll Township have flood reduction benefits of $26,100, $34,600, and $28,600, respectively for the dike plan and nonstructural plan. The city of Port Clinton will accrue $171,800 in flood reduction benefits for both the dike and nonstructural plans as shown on Table B38.

b. Affluence

B8.2 The dollar value of residential contents have been projected to grow at a rate equal to the projected growth rate of the OBERS per capita income in the Toledo, Ohio BEA economic area which includes both Lucas and Ottawa Counties. The growth in residential contents was determined to end when 75 percent of the market value of the typical one-unit structure in the cities of Oregon and Port Clinton was reached. The average annual benefits attributable to contents was determined using the 1979 damages survey conducted by the Buffalo District. With a 2.7 percent annual growth rate in per capita income, the undiscounted average annual benefits are $9,536 for the city of Oregon and $28,670 for the city of Port Clinton. There is a 33-year straight line growth period for the value of contents to reach 75 percent of structure value in Oregon City. Port Clinton has a 30-year straight line growth period for the value of contents to reach 75 percent of the structure value. The average annual affluence benefits are $3,600 for the city of Oregon when the average annual equivalent factor is applied to the 33-year growth period. The average annual equivalent factor for 30 years of growth is .4111263. When the annual equivalent factor is applied to the undiscounted average annual benefits of $28,670, average annual residential benefits are $11,800. The average annual residential affluence factor benefits are $3,600 and $11,800 for the cities of Oregon and Port Clinton, respectively as   wn on Table B39.

B8.3 The residential affluence factor benefits were also calculated for Locust Point, Long Beach, and Sand Beach in Carroll Township as shown on Table B39. Residential affluence factor benefits are $3,300, $4,400, and $3,600 for Locust Point, Long Beach, and Sand Beach, respectively.

Table B38 - Flood Inundation Reduction Benefits

	Plan 1 - Dike			Plan 2 - Nonstructural		
	Existing	Residual	Flood Reduction Benefit	Existing	Residual	Flood Reduction Benefit
	$	$	$	$	$	$
City of Oregon						
Residential	4,600	0	4,600	4,600	900	3,700
Residential-Waves	23,600	0	23,600	23,600	4,700	18,900
Public and Other	2,400	0	2,400	2,400	400	2,000
Total	30,600	0	30,600	30,600	6,000	24,600
Locust Point						
Residential	26,100	0	26,100	26,100	0	26,100
Total	26,100	0	26,100	26,100	0	26,100
Long Beach						
Residential	34,600	0	34,600	34,600	0	34,600
Total	34,600	0	34,600	34,600	0	34,600
Sand Beach						
Residential	28,600	0	28,600	28,600	0	28,600
Total	28,600	0	28,600	28,600	0	28,600

Table B38 - Flood Inundation Reduction Benefits (Cont'd)

	Plan 1 - Dike			Plan 2 - Nonstructural		
	Existing	Residual	Flood Reduction Benefit	Existing	Residual	Flood Reduction Benefit
	$	$	$	$	$	$
City of Port Clinton						
Residential	25,500	0	25,500	25,500	0	25,500
Residential-Waves	68,200	0	68,200	68,200	0	68,200
Commercial	700	0	700	700	0	700
Commercial-Waves	73,400	0	73,400	73,400	0	73,400
Public and Other	4,000	0	4,000	4,000	0	4,000
Total	171,800	0	171,800	171,800	0	171,800

Table B39 - Residential Affluence Benefits

		Annual Growth Rate 1/	$Period_o$	$Period_{33}$	Growth Benefits $P_o - P_{33}$	Average Annual Equivalent Factor 2/	Average Annual Residential Affluence Factor Benefits
City of Oregon							
Structures	21,432	2.7	21,432				
Contents	6,768		6,768	16,304	9,536	.3814095	3,637
							say
Total	28,200		28,200				3,600

		Annual Growth Rate 1/	$Period_o$	$Period_{30}$	Growth Benefits $P_o - P_{30}$	Average Annual Equivalent Factor 3/	Average Annual Residential Affluence Factor Benefits
City of Port Clinton							
Structures	70,275	2.7	70,275				
Contents	23,425		23,425	52,095	28,670	.4111263	11,787
							say
Total	93,700		93,700				11,800
Locust Point							
Structures	19,575	2.7	19,575				
Contents	6,525		6,525	14,511	7,986	.4111263	3,283
							say
Total	26,100		26,100				3,300

Table B39 - Residential Affluence Benefits (Cont'd)

		Annual Growth Rate 1/	$Period_o$	$Period_{30}$	Growth Benefits P_o-P_{30}	Average Annual Equivalent Factor 3/	Average Annual Residential Affluence Factor Benefits
Long Beach							
Structures	25,950	2.7	25,950				
Contents	8,650		8,650	19,237	10,587	.4111263	4,353 say
Total	34,600		34,600				4,400
Sand Beach							
Structures	21,450	2.7	21,450				
Contents	7,150		7,150	15,901	8,751	.4111263	3,598 say
Total	28,600		28,600				3,600

1/ SOURCE: OBER's Projections, Volume 2, BEA Economic Areas, U. S. Water Resources Council, April 1974.
2/ Given 7-3/8 percent interest rate, 50-year project life, 33 years' growth.
3/ Given 7-3/8 percent interest rate, 50-year project life, 30 years' growth.

c. Erosion Benefits

(1) Introduction

B8.4 The erosion process in the cities of Oregon and Port Clinton were examined for this study. Benefits will accrue for the cities of Port Clinton and Oregon throughout the project planning period (1990-2040) due to erosion along the Lake Erie shoreline. The recession rate for the city of Oregon is 9 feet per year according to the historical record (1877-1943). The recession rate for Port Clinton ranges from slow to very slow. The very slow rate, .5 foot per year, occurs from the Catawba Island Township boundary to Wonnell Ditch. The slow rate of recession, 2 feet per year, occurs along the shoreline of Port Clinton from the Wonnell Ditch to the mouth of the Portage River.

B8.5 The erosion benefits for private residential property and privately-owned shoreline are not included as NED benefits since Federal or public funds should not be spent for private benefit (i.e., the benefit of a specific individual at a specific location). According to House Document 272, 86th Congress, p. 27, the private residential erosion benefits are not eligible for inclusion in the National Economic Development (NED) account. The document also states on p. 28 that "there is no direct Federal interest. . . since none of these shores are owned by the United States." Existing Corps regulations limit, for the most part, Federal participation in erosion control problems to publicly-owned lands. The protection of private shoreline property is authorized under ER 1165-2-130 if such protection were incidental to the protection of public-owned shores or if such protection would result in public benefits. [redacted].

(2) Road Loss Reduction Benefits

B8.6 The prevention of the loss of existing roads subject to erosion in the city of Oregon from Stadium Road to Norden Road is a benefit under the with project condition. The cost of reconstruction of city roads was used as a proxy to measure the benefits for this category. The cost of reconstruction of city roads was estimated at $77.50 per lineal foot. The embayment areas indicated on Plate B24 are subject to erosion. The road loss reduction benefits for Bayshore Road were determined by the methodology shown in Table B40. The setback distance was determined by examining 1978 aerial photography. The total feet of road subject to erosion during the planning period (1990-2040) multiplied by the cost per foot for reconstruction yields undiscounted road loss reduction benefits. Multiplying by the present worth of $1 per period and amortizing over the 50-year project life yields average annual road loss reduction benefits. The total road loss reduction benefits for Bayshore Road are $900. The Bayshore Boulevard, also subject to erosion, runs perpendicularly to Lake Erie. With expenditures of $77.50 per foot for 9 feet per year, average annual reconstruction costs avoided are $698. Total road loss reduction benefits are $1,600. The road loss reduction benefits category was not determined for the city of Port Clinton since none of the roads will be subject to erosion during the planning period (1990-2040).

Table B40 - Derivation of Road Loss Reduction Benefits

Area Setback 1978	(1) Feet Subject to Erosion	(2) Lineal Cost per Foot	(3) Undiscounted Road Loss Reduction Benefits	(4) Present Worth of $1	(5) Total Road Loss Reduction Benefits	(6) Amortization Factor	(7) Average Annual Road Loss Reduction Benefits
		$	$		$		$
Bayshore Road							
1 300 feet	550	77.50	42,630	.22441 1/	9,567	.07591 2/	726
2 450 feet	550	77.50	42,630	.06694 3/	2,854	.07591 2/	217
							943
							say
							940

1/ Present worth of $1 factor for 21 years, given 7-3/8 percent interest rate, 50-year project life.
2/ Given 7-3/8 percent interest rate, 50-year project life, amortization factor is .07591.
3/ Present worth of $1 factor for 38 years, given 7-3/8 percent interest rate, 50-year project life.

(3) Relocation Costs

B8.7 The city of Oregon is fully serviced by gas, sanitary sewer, and electric utilities in the area subject to erosion between Norden and Stadium Roads. The cost of relocation for each lineal foot of gas, electric, and sanitary sewer lines along Bayshore Road and Bayshore Boulevard was determined. The relocation cost estimate for electrical utilities is $10 per lineal foot based on estimates by the Toledo Edison Company. The relocation cost for gas lines was estimated to be $21 per lineal foot by the West Ohio Gas Company. The sewer line relocation costs were estimated to be $110 per lineal foot by the Finklebeiner, Pettis and Strout Limited, Consulting Engineers of Toledo, Ohio. The cost estimates per lineal foot for gas lines and sewer line relocation include tie-ins and necessary fittings and replacements for sewer lines and gas lines. The total relocation cost avoided for gas lines, sewer lines, and electric utility lines is based on the lineal feet of utility lines subject to erosion during the planning period 1990-2040. The procedure used to derive relocation costs avoided for sewer lines is shown on Table B41 for Bayshore Road which runs parallel to Lake Erie. The total feet of sewer lines subject to erosion multiplied by the cost per foot for relocation yields undiscounted relocation costs avoided. Multiplying by the present worth of $1 per period and amortizing over the 50-year project life yields average annual relocation costs avoided. Sewer line relocation costs for Bayshore Road are $1,300 as shown on Table B41. Bayshore Boulevard, also subject to erosion, runs perpendicularly to Lake Erie. With expenditures of $110 per foot for 9 feet per year, average annual relocation costs avoided are $990. Total sewer line relocation costs avoided for Bayshore Boulevard ($1,300) and Bayshore Road ($990) are $2,300.

B8.8 The derivation of gas and electric line relocation costs avoided was determined by the procedure shown in Table B41. The total gas line relocation costs avoided are $500 for Bayshore Road and Bayshore Boulevard while electric line relocation costs avoided are $200 for the same streets. Total relocation costs avoided are $3,000 for the city of Oregon. The relocation costs avoided benefit category was not determined for the city of Port Clinton since none of the utility lines will be threatened by erosion during the project planning period (1990-2040).

Table B41 - Derivation of Relocation Costs Avoided, Bayshore Road Sewer Line

Area Setback 1978	Feet Subject to Erosion	Lineal Cost per Foot	Undiscounted Relocation Costs Avoided	Present Worth of $1	Total Relocation Costs Avoided	Amortization Factor	Average Annual Relocati Costs Avoided
		$	$		$		$
Bayshore Road							
1 300 feet	550	110	60,500	.22441 1/	13,577	.07591 2/	1,031
2 450 feet	550	110	60,500	.06694 3/	4,050	.07591 2/	307
							1,338
							say
							1,300

1/ Present worth of $1 factor for 21 years, given 7-3/8 percent interest rate, 50-year project life.
2/ Given 7-3/8 percent interest rate, 50-year project life, amortization factor is .07591.
3/ Present worth of $1 factor for 38 years, given 7-3/8 percent interest rate, 50-year project life.

B9 - SUMMARY OF BENEFITS

B9.1 The 11,000 feet clay dike structure designed to provide the city of Oregon with flood control protection will yield $38,800 in benefits. The benefits include flood reduction benefits of $30,600, residential affluence benefits of $3,600 and total erosion reduction benefits of $4,600. The nonstructural alternative of raising the first floor and floodproofing will yield a total of $32,800 in benefits including flood reduction benefits of $24,600, residential affluence benefits of $3,600, and erosion reduction benefits of $4,600. Locust Point, Long Beach, and Sand Beach structural (dike) and nonstructural (raising first floor elevation) plans yield combined flood reduction benefits and affluence factor benefits of $29,400, $39,000, and $32,200, respectively. The total average annual benefits for the proposed 2,000, 4,000, and 12,000 feet dikes at the city of Port Clinton are shown in Table B42. The average annual benefits for the Western Lake Erie Shore dike are $1,046,800. The benefits for the Western Lake Erie Shore dike include the agricultural benefits for rural areas along the shoreline. The summary of benefits for the Western Lake Erie Shore dike are presented in Table B43.

Table B42 - Summary of Benefits

	PLAN 1 Dike $		PLAN 2 Nonstructural $	
<u>City of Oregon</u>				
Flood Reduction Benefits	30,600		24,600	
Residential		(28,200)		(22,600)
Public and Other		(2,400)		(2,000)
Affluence - Residential	3,600		3,600	
Erosion Reduction Benefits	4,600		4,600	
Road Loss Reduction Benefits		(1,600)		(1,600)
Relocation Costs Avoided		(3,000)		(3,000)
Total	38,800		32,800	
<u>Locust Point</u>				
Flood Reduction Benefits				
Residential	26,100		26,100	
Affluence - Residential	3,300		3,300	
Total	29,400		29,400	
<u>Long Beach</u>				
Flood Reduction Benefits				
Residential	34,600		34,600	
Affluence - Residential	4,400		4,400	
Total	39,000		39,000	
<u>Sand Beach</u>				
Flood Reduction Benefits				
Residential	28,600		28,600	
Affluence - Residential	3,600		3,600	
Total	32,200		32,200	
<u>City of Port Clinton</u>				
Flood Reduction Benefits	171,800		171,800	
Residential		(93,700)		(93,700)
Commercial		(74,100)		(74,100)
Public and Other		(4,000)		(4,000)
Affluence - Residential	11,800		11,800	
Total	183,600		183,600	

Table B43 - Summary of Benefits
Western Lake Erie Shore Dike

	$	
Flood Reduction Benefits	997,500	
Residential		(211,200)
Commercial		(74,100)
Public and Other		(6,400)
Agricultural		(705,800)
Affluence Residential	26,700	
Erosion Reduction Benefits	4,600	
Road Loss Reduction Benefits		(1,600)
Relocation Costs Avoided		(3,000)
Total	1,028,800	

B10 - PROJECT COSTS

B10.1 The total project costs are summarized in Table B44 for a dike alternative and a nonstructural alternative for the city of Oregon, Locust Point, Long Beach, Sand Beach, and the city of Port Clinton. A cost estimate for constructing approximately 33 miles of shoreline dike that would provide flood and erosion protection for agricultural lands, commercial developments, and residential developments is shown in Table B44. The shoreline dike would supplement the existing system of protection.

B10.2 The "least-cost" method of structurally protecting each of the erosion and floodprone areas was used for areas identified as having sufficient damages to justify further study. Maintenance costs have not been included in order to assure that potentially feasible projects would not be eliminated in this study. If the benefit-cost ratio does not exceed .9 with the conservative cost estimates and liberal benefit determinations, the area would be eliminated from further consideration.

B10.3 The detailed cost estimates for the 11,000 lineal feet of clay dike for the city of Oregon are given in Table B45. The nonstructural plan for the city of Oregon includes raising the first floor and floodproofing. The nonstructural plans for Locust Point, Long Beach, and Sand Beach would consist of raising the first floor elevation of homes which would sustain first floor flooding during an occurrence of the 100-year flood. The structural plans for these areas consists of the construction of shoreline dikes. Detailed cost estimates for 22,000 feet of shoreline dike in the city of Port Clinton are provided in Table B45. The nonstructural Plan 2 for the city of Port Clinton includes floodproofing, evacuation, and elevation of structures.

Table B44 - Total Project Costs, West Coast Lake Erie 1/

Problem Area	Total Construction Cost $ Plan 1 Dike	Total Construction Cost $ Plan 2 Nonstructural	Total Annual Charges $ Plan 1 Dike	Total Annual Charges $ Plan 2 Nonstructural
City of Oregon	5,547,000	660,000	421,000	50,000
Locust Point	650,000	930,000	49,300	70,000
Long Beach	925,000	630,000	70,000	48,000
Sand Beach	1,700,000	485,000	126,000	36,800
Port Clinton	5,119,000	3,315,000	389,000	251,000
Western Lake Erie Shore	100,000,000	-	7,591,000	-

1/ Given 7-3/8 percent interest rate, 50-year project life.

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WESTERN LAKE ERIE SHORE STUDY, OHIO. RECONNAISSANCE REPORT (STA--ETC(U)
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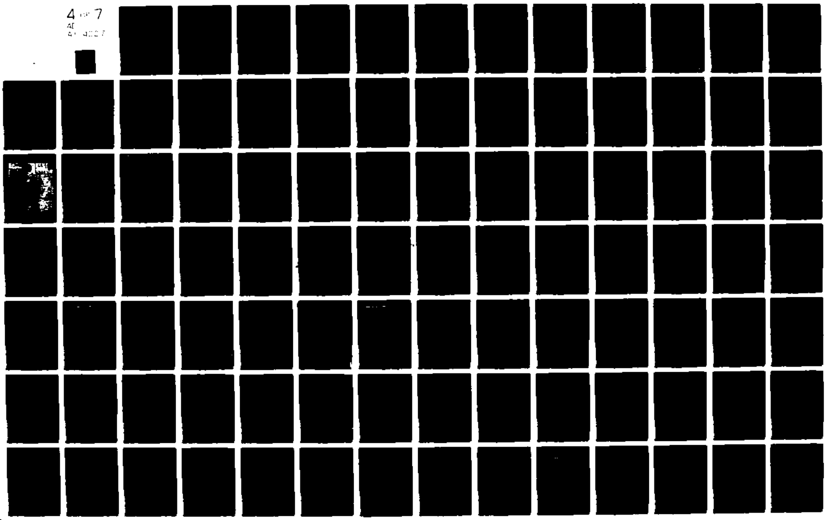


Table B45 - City of Oregon and City of Port Clinton, Project Costs, 7-3/8 Percent, 50-Year Project Life

City of Oregon	
	$
First Cost Construction	4,410,000
Engineering and Design	661,500
Supervision and Administration	475,000
Total Cost Construction	5,546,500
	say
	5,547,000
Annual Charges	
Interest	409,137 1/
Amortization	11,964 1/
Total Annual Charges	421,101
	say
	421,000

City of Port Clinton	
	$
First Cost Construction	
In Water	3,420,000
On Land	650,000
Total First Cost Construction	4,070,000
Engineering and Design	610,000
Supervision and Administration	438,400
Total Cost Construction	5,118,900
	say
	5,119,000
Annual Charges	
Interest	377,568 1/
Amortization	11,041 1/
Total Annual Charges	388,609
	say
	389,000

1/ Given 7-3/8 percent interest rate, 50-year project life.

B11 - ECONOMIC EFFICIENCY

B11.1 Three measures of economic efficiency were developed for the structural (dike) and nonstructural alternatives for areas along the Western Lake Erie Shore. They are the benefit-cost ratio, net discounted benefits, and payback.

B11.2 The benefit-cost ratio is the ratio of average annual benefits to average annual costs at the project interest rate of 7-3/8 percent. The benefit-cost ratio for the clay dike protection at the city of Oregon is .12. The dike protection for the city of Port Clinton yields a benefit-cost ratio of .49. The nonstructural alternatives yield benefit-cost ratios of .86 for the city of Oregon and .76 for Port Clinton. The benefit-cost ratios for structural and nonstructural plans for Locust Point, Long Beach, and Sand Beach are also shown in Table B46. The structural dike plan yields benefit-cost ratios of .60, .56, and .26 for Locust Point, Long Beach, and Sand Beach, respectively. Nonstructural plans yield benefit-cost ratios of .42, .81, and .88 for Locust Point, Long Beach, and Sand Beach, respectively. The benefit-cost ratio for the protection of 33 miles of shoreline in the Western Lake Erie area is .14.

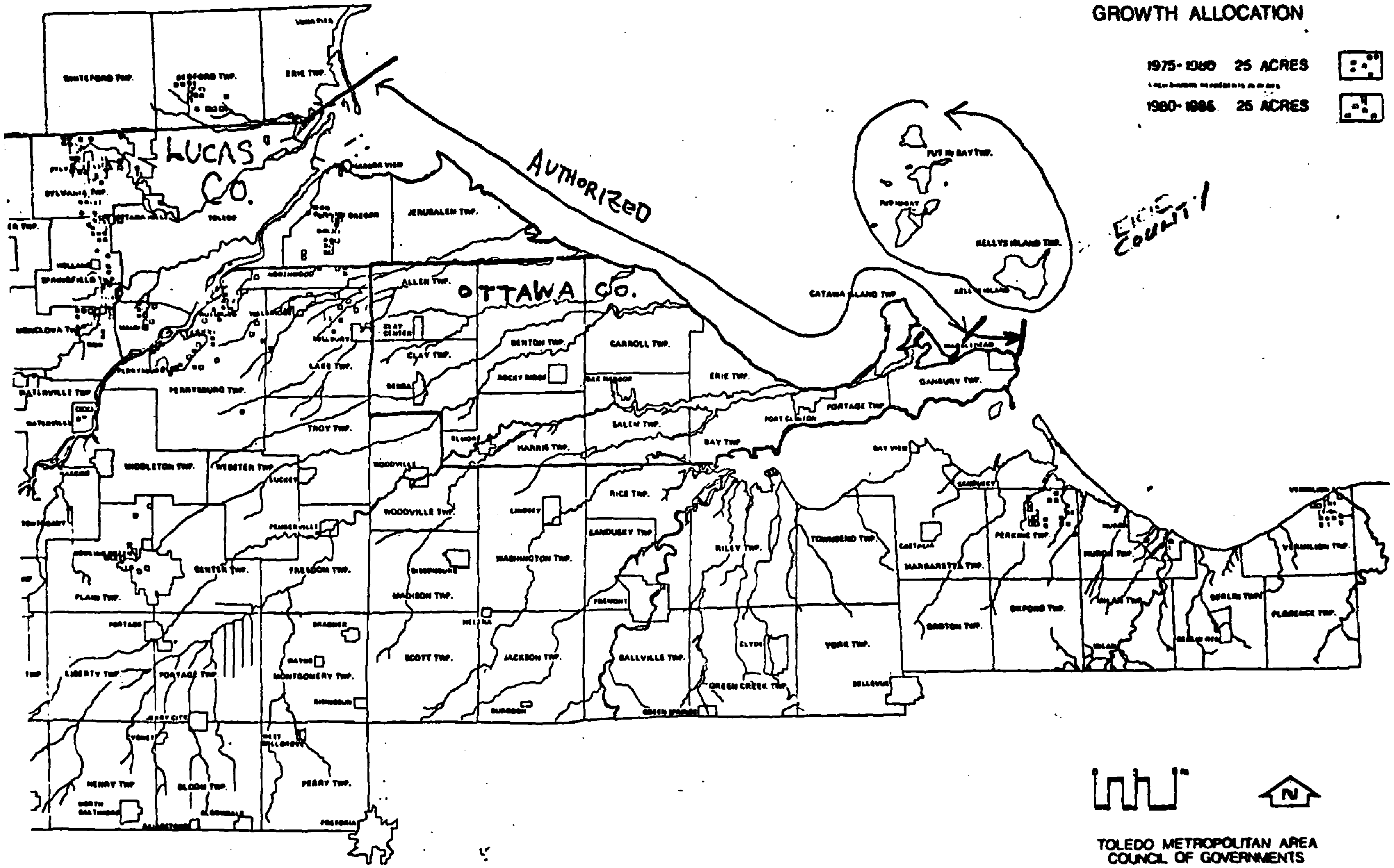
B11.3 Net discounted benefits are the present value of benefits in excess of project costs. The net discounted benefits measure the present value of the project beneficial effects over the planning period. Net discounted benefits are $-371,900 for the dike alternative of the city of Oregon. The nonstructural alternative yields net discounted benefits of $-6,900. The areas of Locust Point, Long Beach, and Sand Beach were also evaluated for net discounted benefits as shown on Table B46. The city of Port Clinton clay dike structure will provide $-197,700 negative net benefits. The nonstructural alternative for the city of Port Clinton yields net negative discounted benefits of $-59,700. The shoreline dike for the Western Lake Erie Shore yields negative net discounted benefits of $-6,544,200.

B11.4 The project payback period is the amount of time it takes for undiscounted annual benefits to equal the project costs. The project payback for each project is given on Table B46.

B11.5 Based upon this economic evaluation, neither the dike nor the nonstructural alternatives are economically justified for the city of Oregon, Locust Point, Long Beach, Sand Beach, and Port Clinton. The plan for 33 miles of shoreline dike for the Western Lake Erie Shore is also not economically justifiable on the basis of the economic analysis. All of the plans for this study have benefit-cost ratios of less than unity and have negative net discounted benefits.

Table B46 - Economic Efficiency

Problem Area	Investment Cost	Average Annual Benefits	Average Annual Costs	B/C Ratio	Net Discounted Benefits	Payback
	$	$	$		$	
City of Oregon						
Plan 1 Dike	5,547,000	38,800	421,000	.09	-382,200	143 years
Plan 2 Nonstructural	660,000	32,800	50,000	.66	-17,200	20 years
Locust Point						
Plan 1 Dike	650,000	29,400	49,300	.60	-19,900	22 years
Plan 2 Nonstructural	930,000	29,400	70,000	.42	-40,600	32 years
Long Beach						
Plan 1 Dike	925,000	39,000	70,000	.56	-31,000	24 years
Plan 2 Nonstuctural	630,000	39,000	48,000	.81	-9,000	16 years
Sand Beach						
Plan 1 Dike	1,700,000	32,200	126,000	.26	-93,800	53 years
Plan 2 Nonstructural	485,000	32,200	36,800	.88	-4,600	15 years
City of Port Clinton						
Plan 1 Dike	5,119,000	183,600	389,000	.47	-205,400	28 years
Plan 2 Nonstructural	3,315,000	183,600	251,000	.73	-67,400	18 years
Western Lake Erie Shore						
Plan 1 Dike	100,000,000	1,028,800	7,591,000	.14	-6,562,200	97 years



AREA DESCRIPTION

PLATE B1

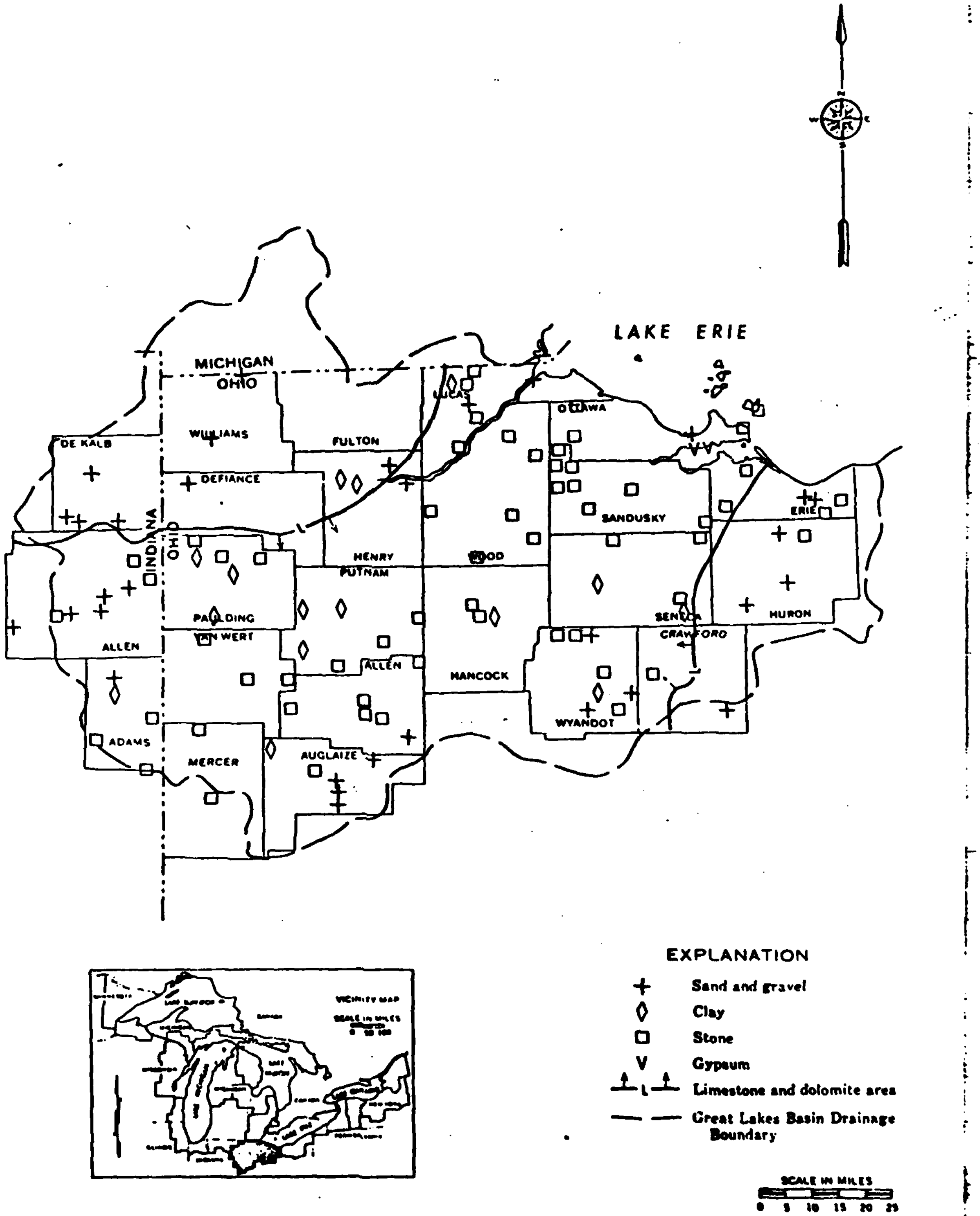


FIGURE 5-11 Planning Subarea 4.2: Distribution of Mineral Operations Active in 1968 and Major Mineral Resource Areas

PLATE 82
MINERAL RESOURCES

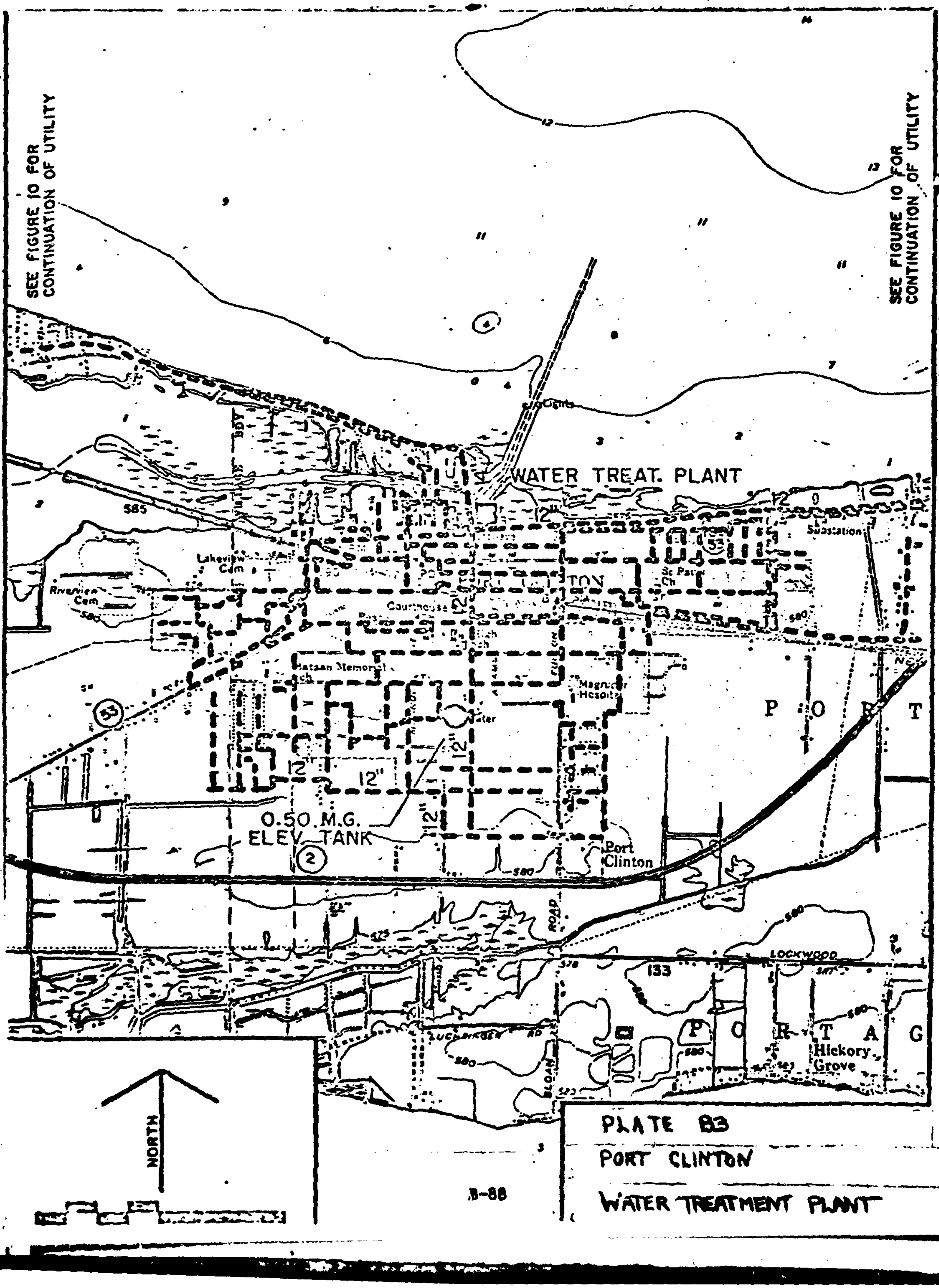


PLATE B3

PORT CLINTON

WATER TREATMENT PLANT

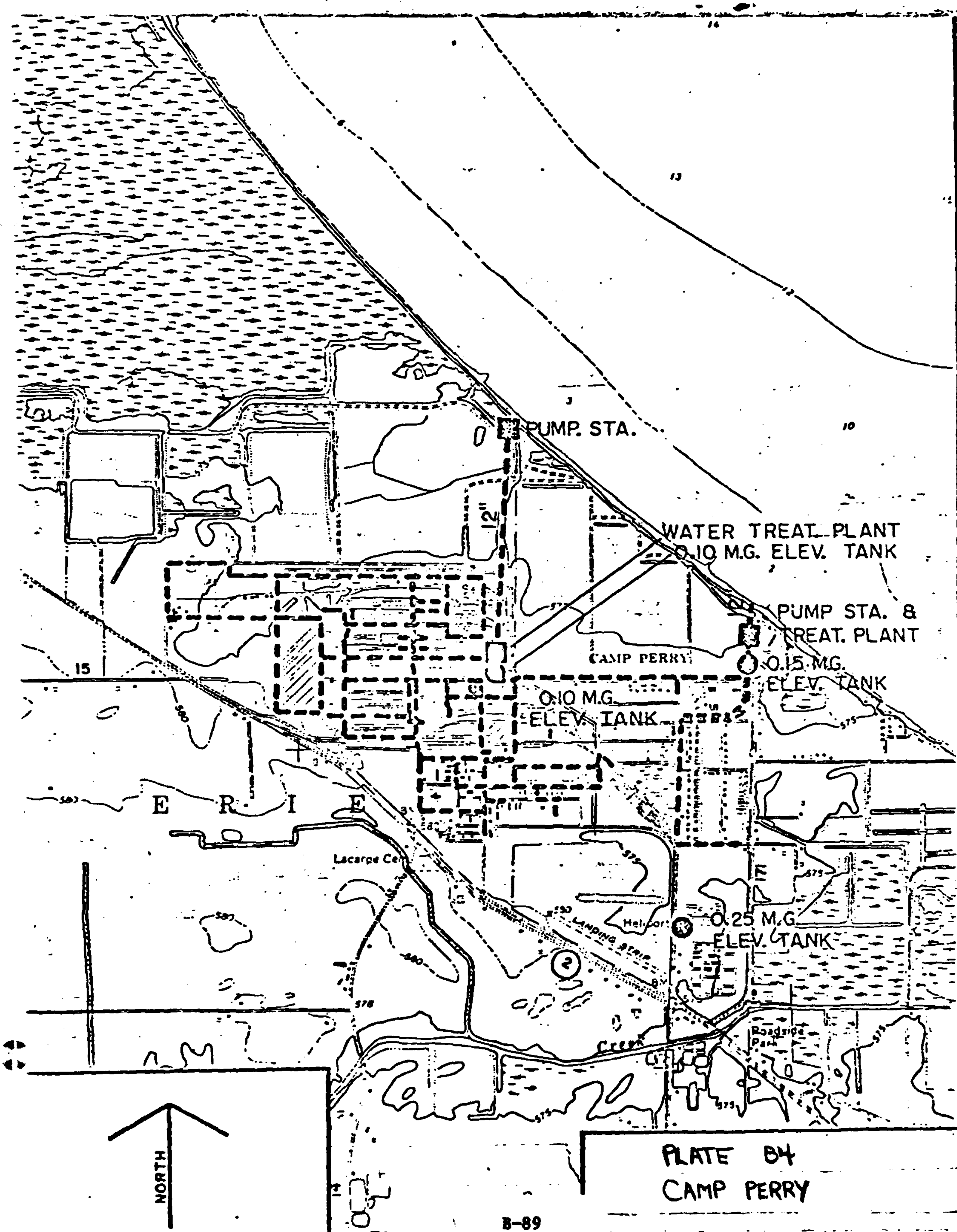


PLATE B4
CAMP PERRY

WATER TREATMENT FACILITY

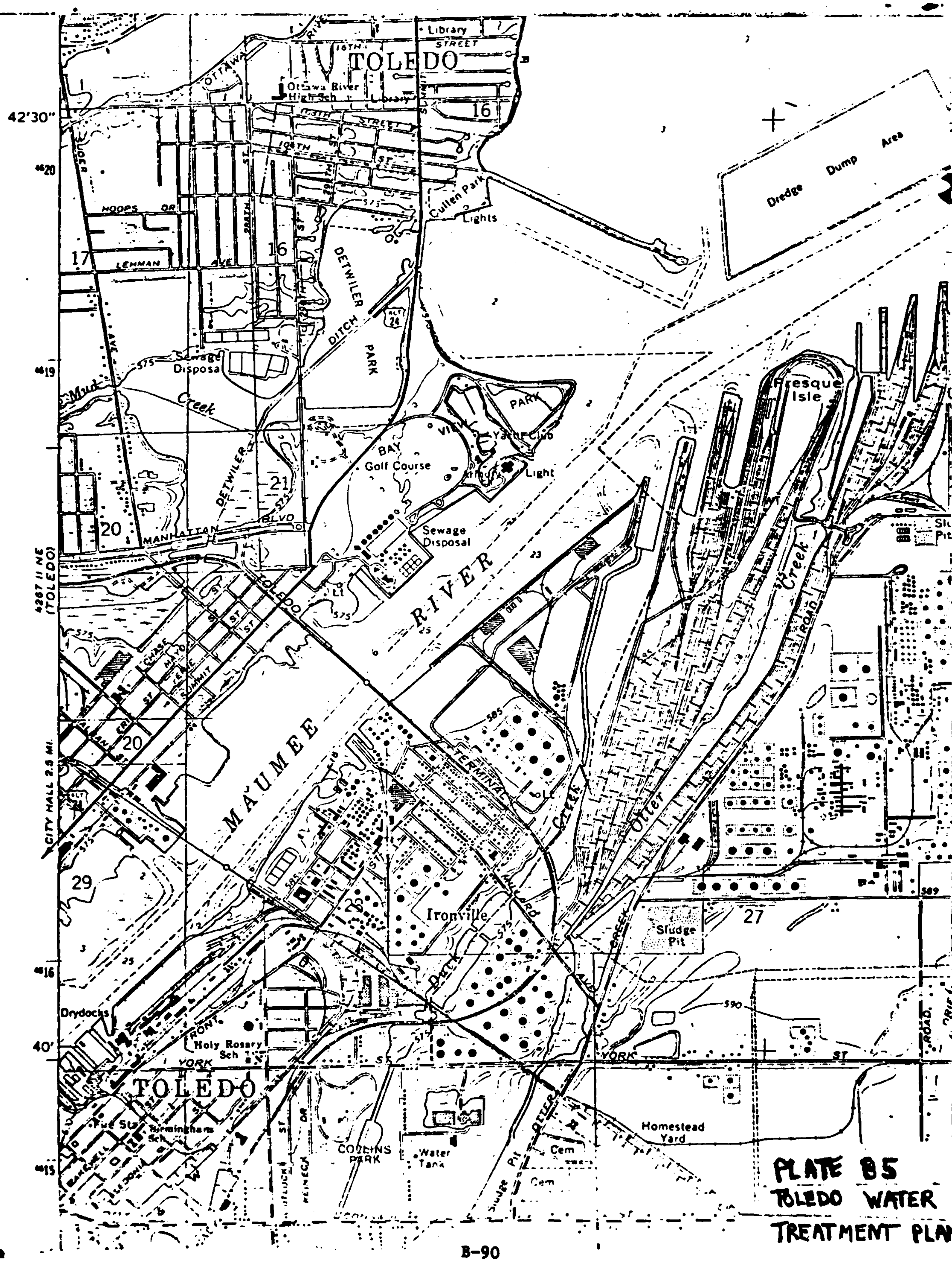


PLATE 85
TOLEDO WATER
TREATMENT PLANT

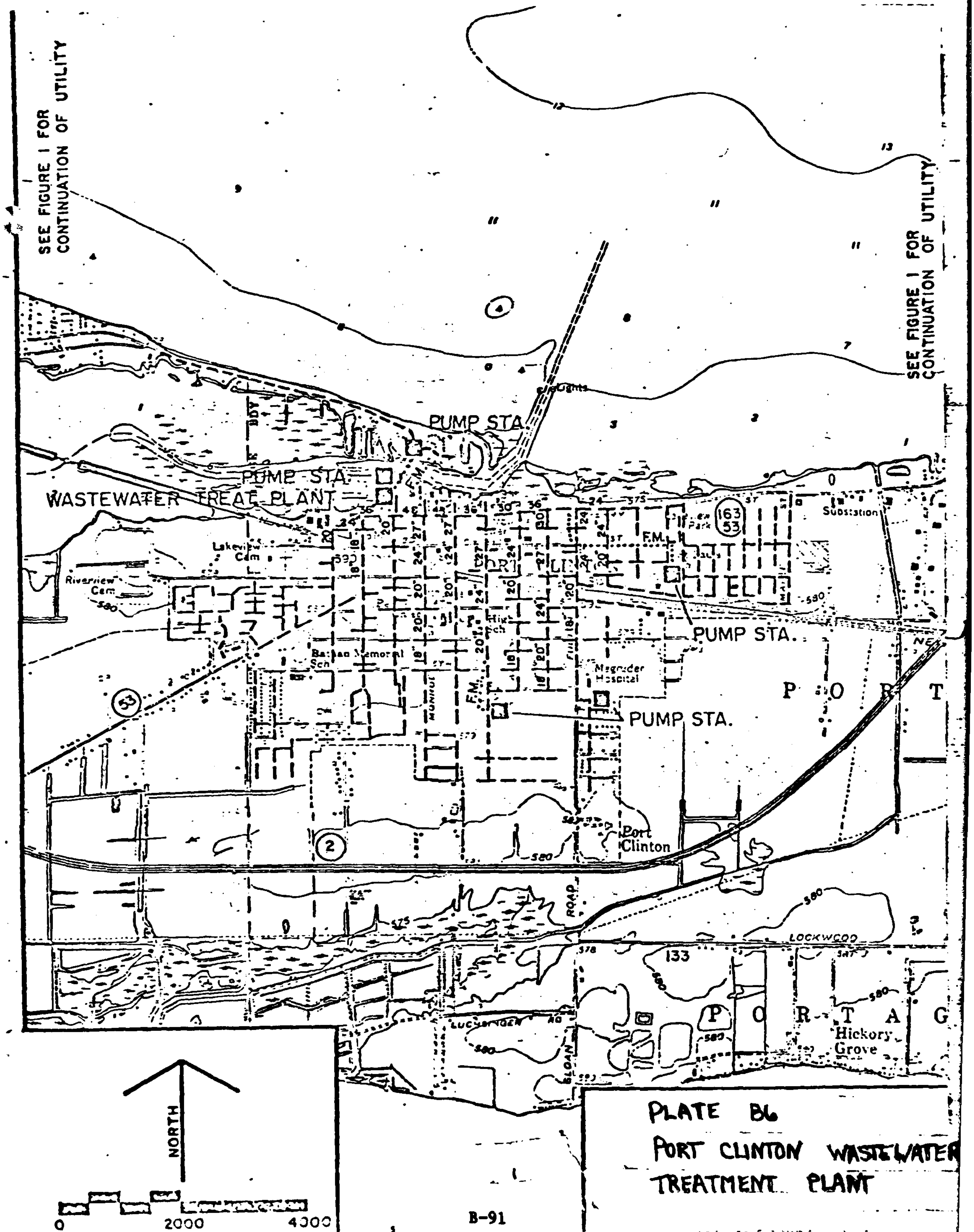


PLATE B6

PORT CLINTON WASTEWATER TREATMENT PLANT

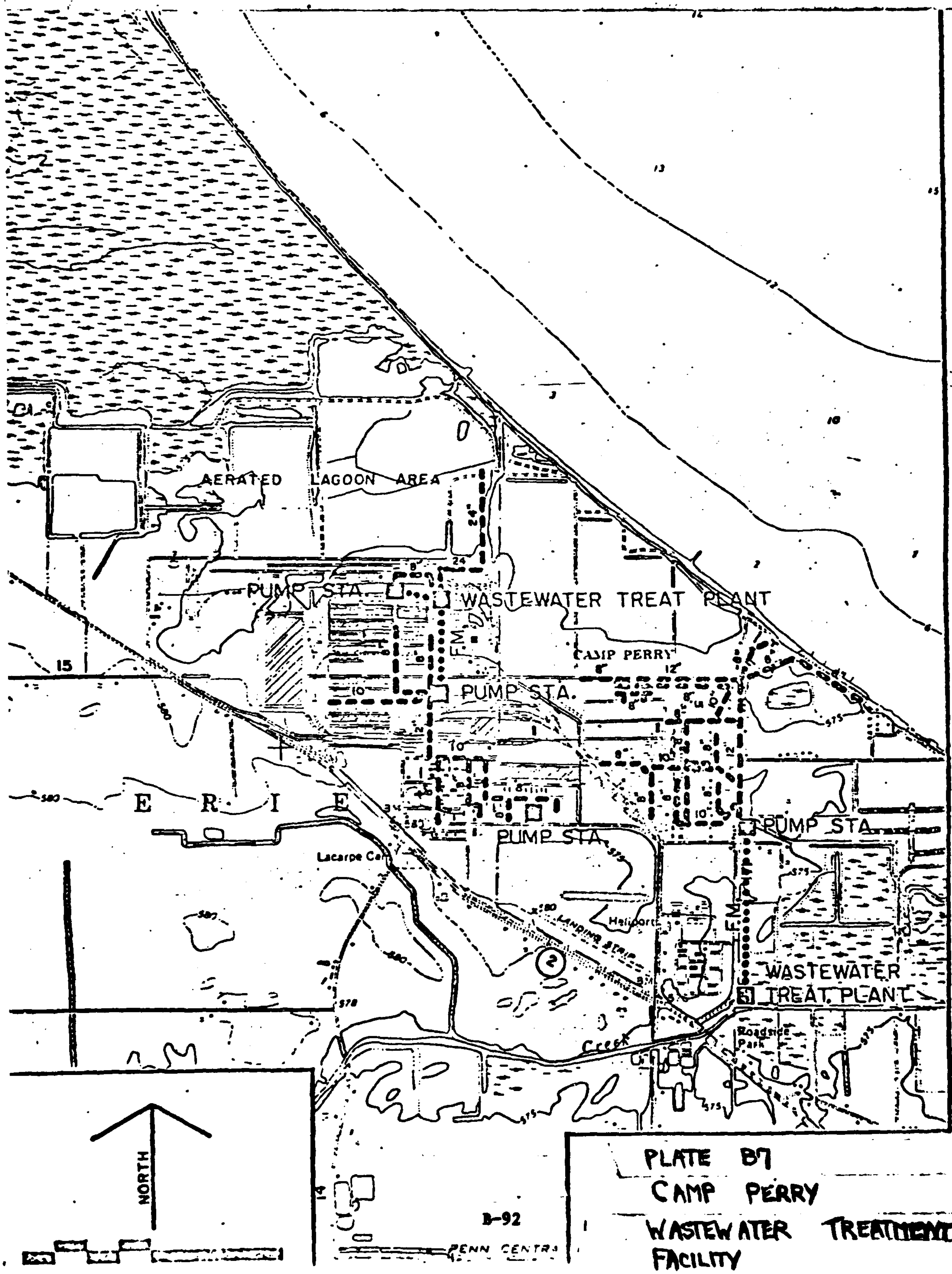
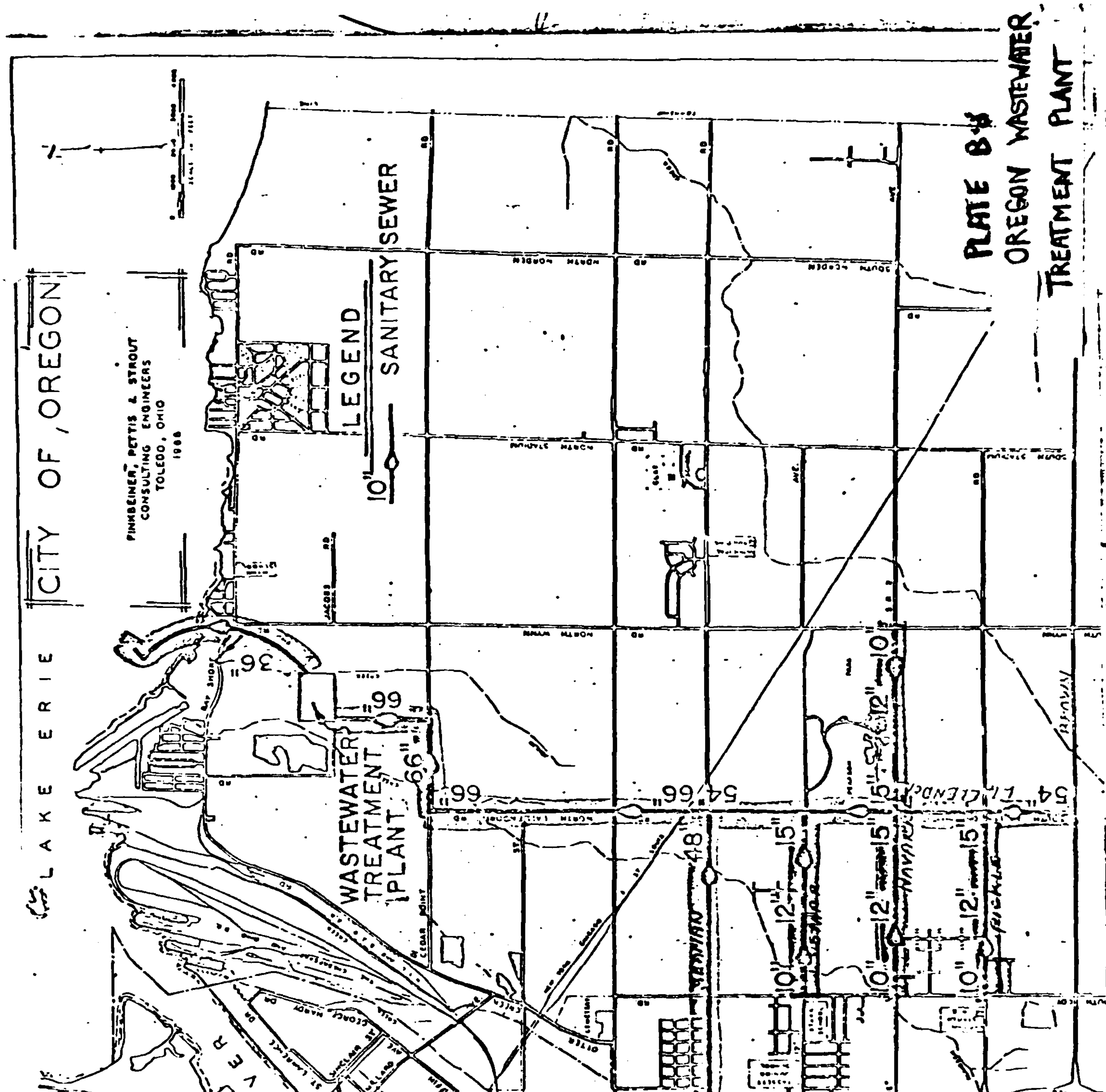


PLATE B7
CAMP PERRY
WASTEWATER TREATMENT FACILITY



CITY OF OREGON
LAKE ERIE
FINKBEINER, PETTIS & STROUT
CONSULTING ENGINEERS
TOLEDO, OHIO
1968
LEGEND
10" SANITARY SEWER
WASTEWATER TREATMENT PLANT
MAUMEE RIVER
PLATE B-8
OREGON WASTEWATER TREATMENT PLANT

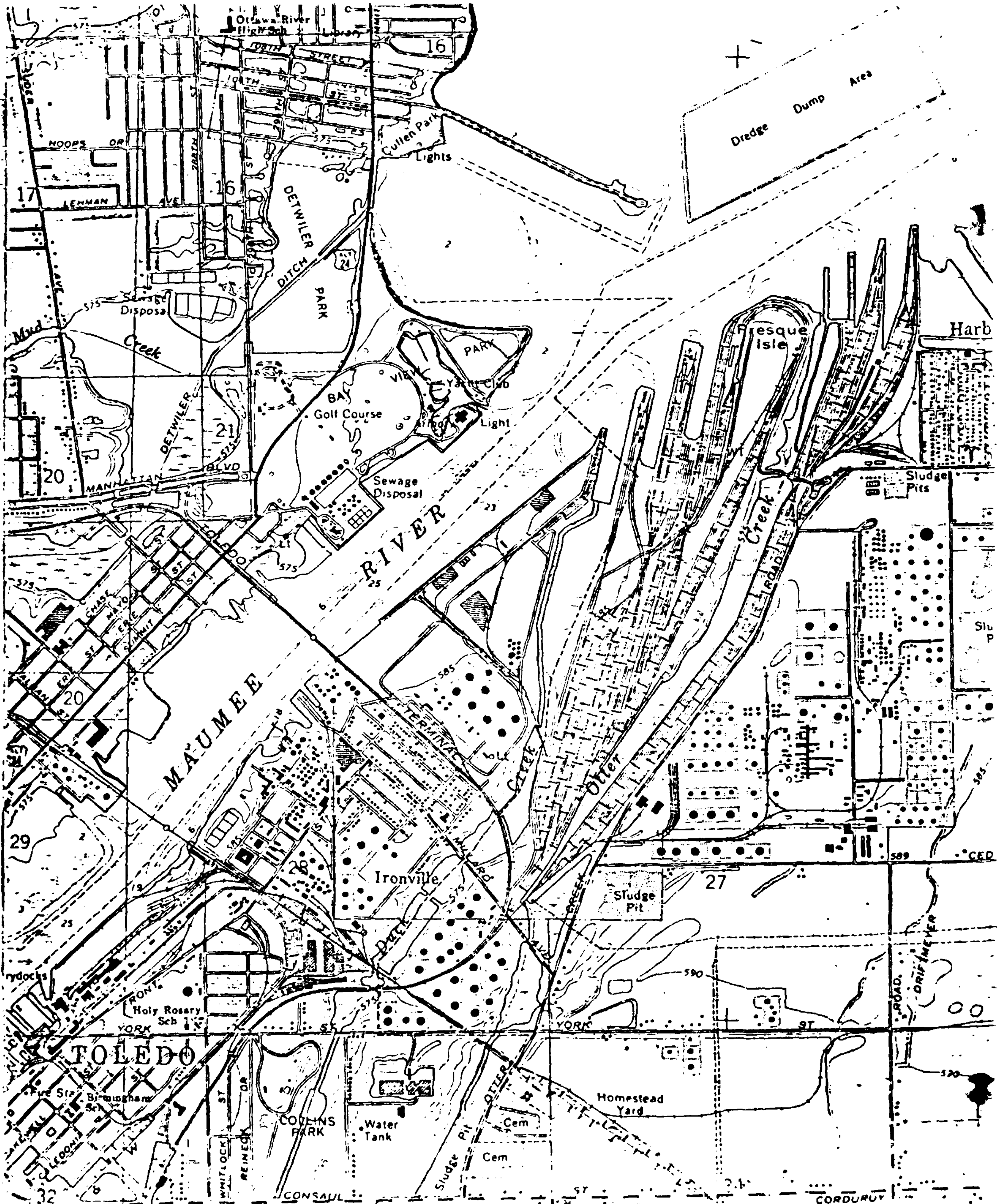
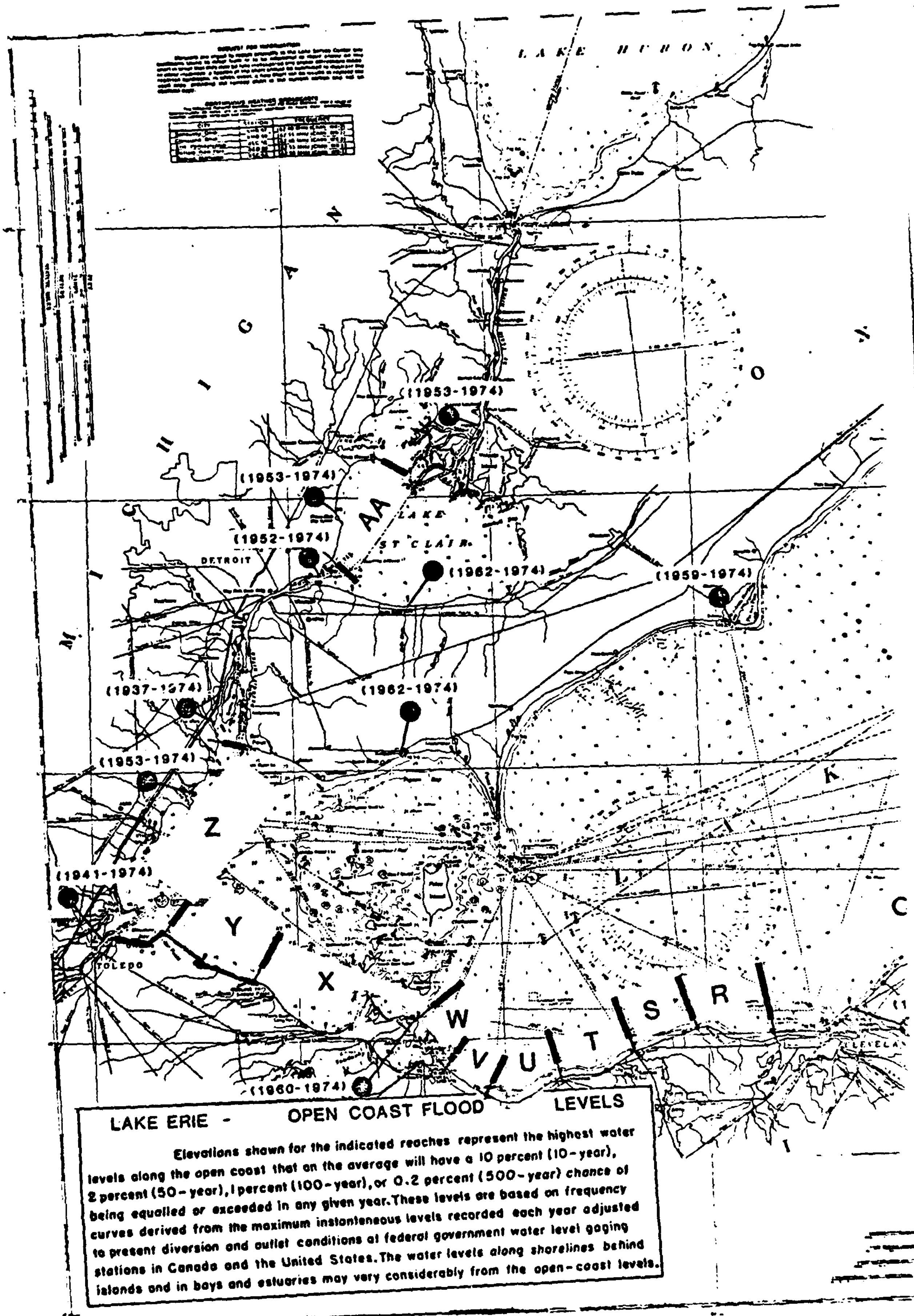


PLATE B9

TOLEDO WASTEWATER TREATMENT PLANT



WEST COAST LAKE ERIE 2/12 PLATE B10

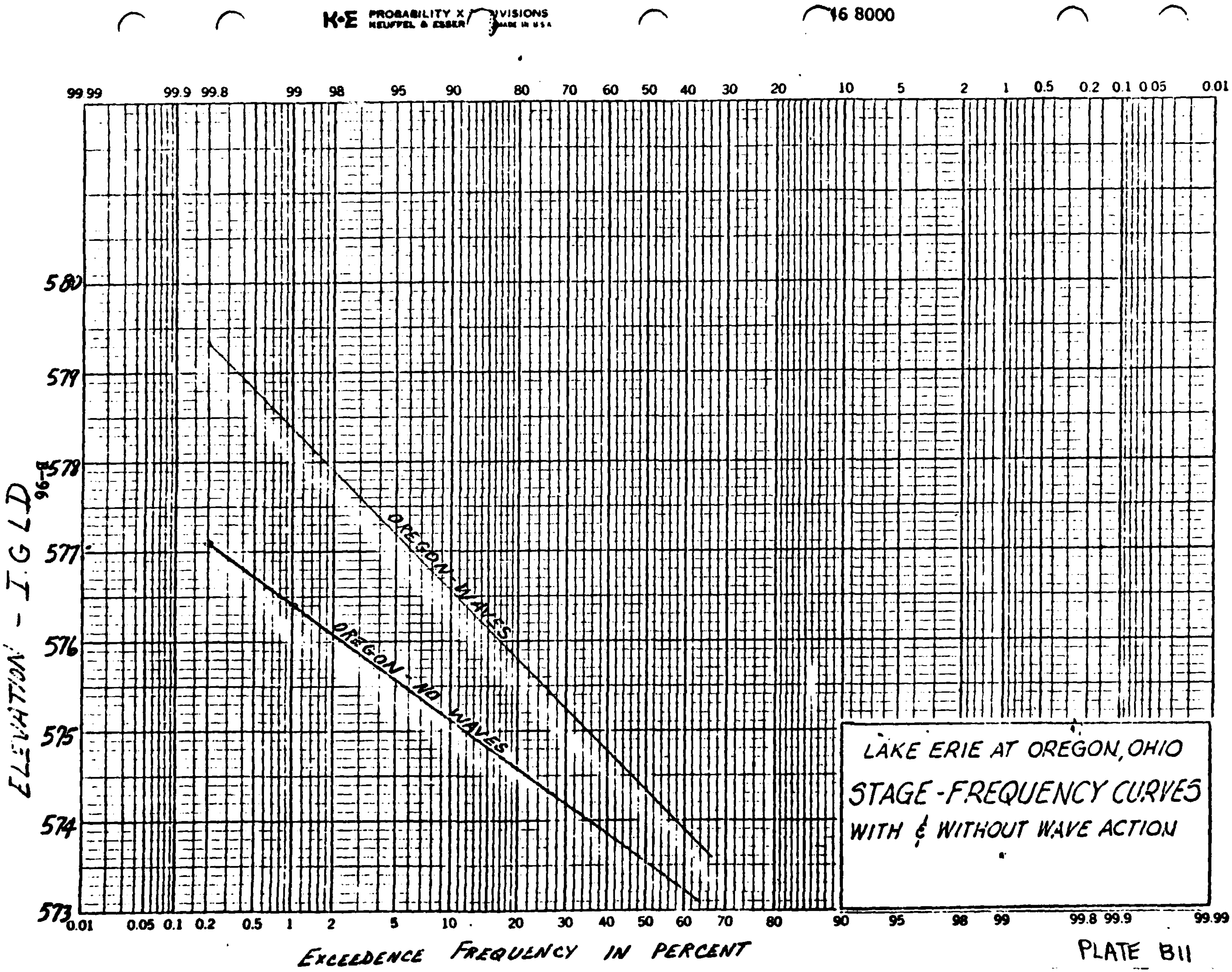


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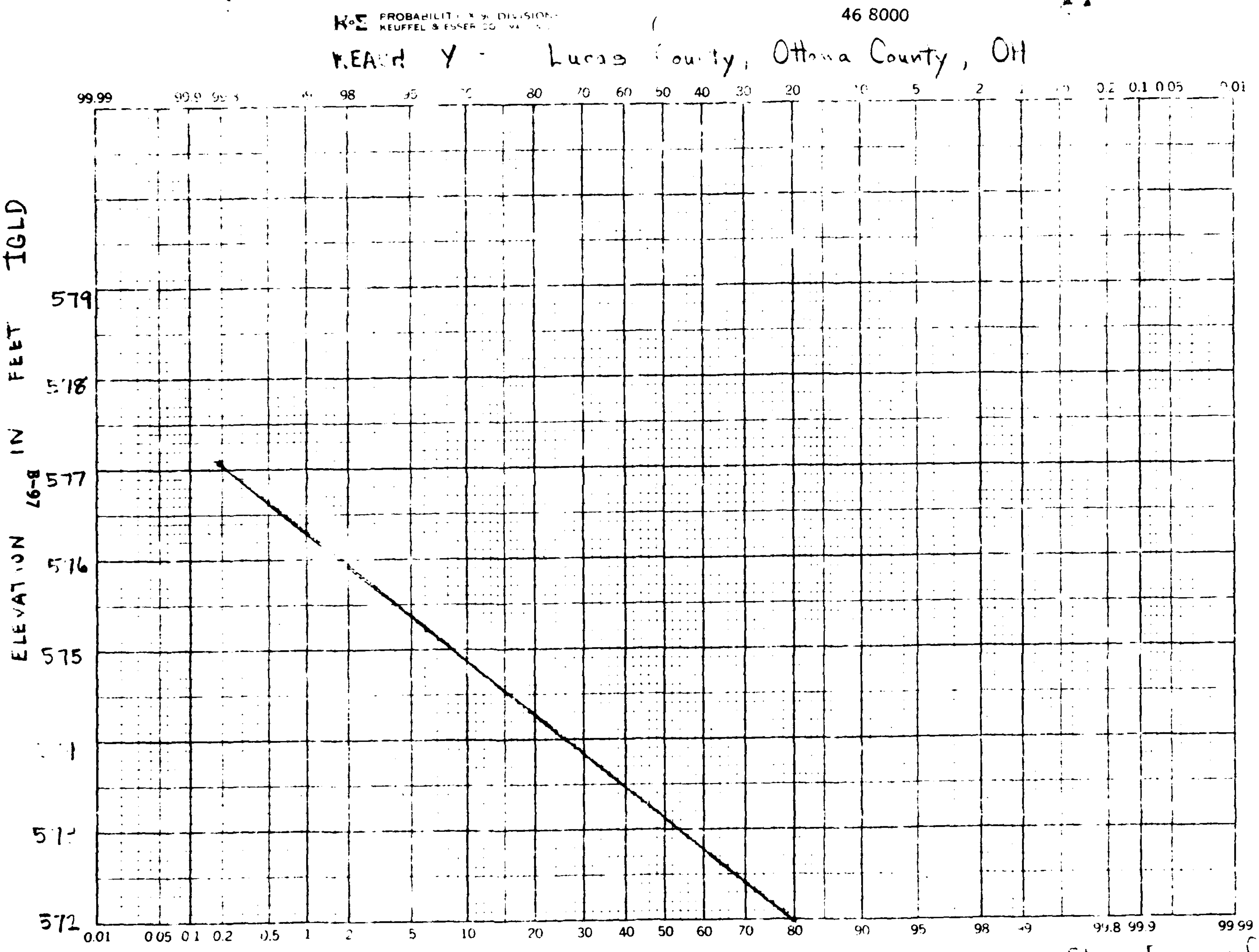
PLATE B11



Stage-Frequency Curv
PLATE B-12

B-97

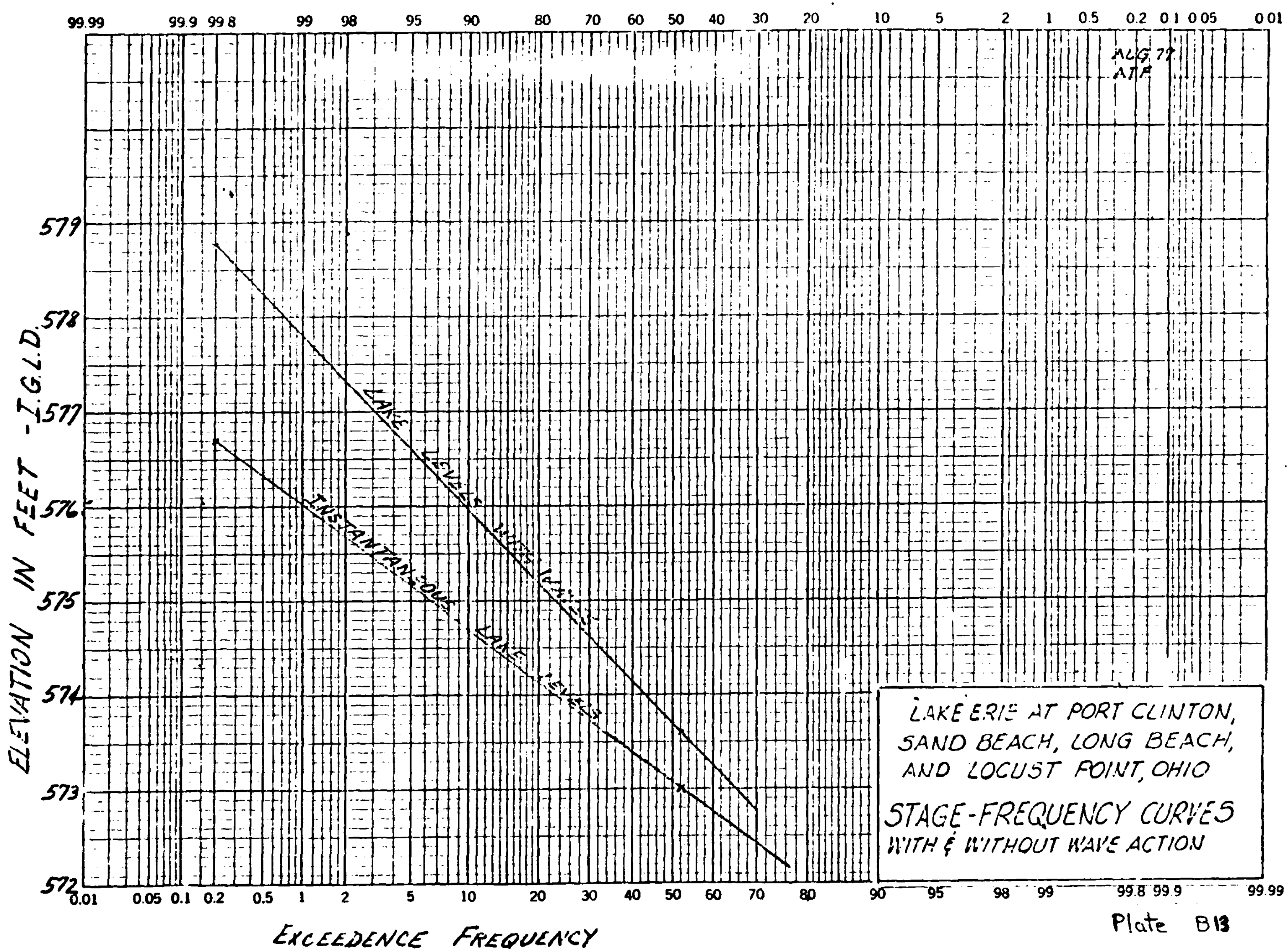
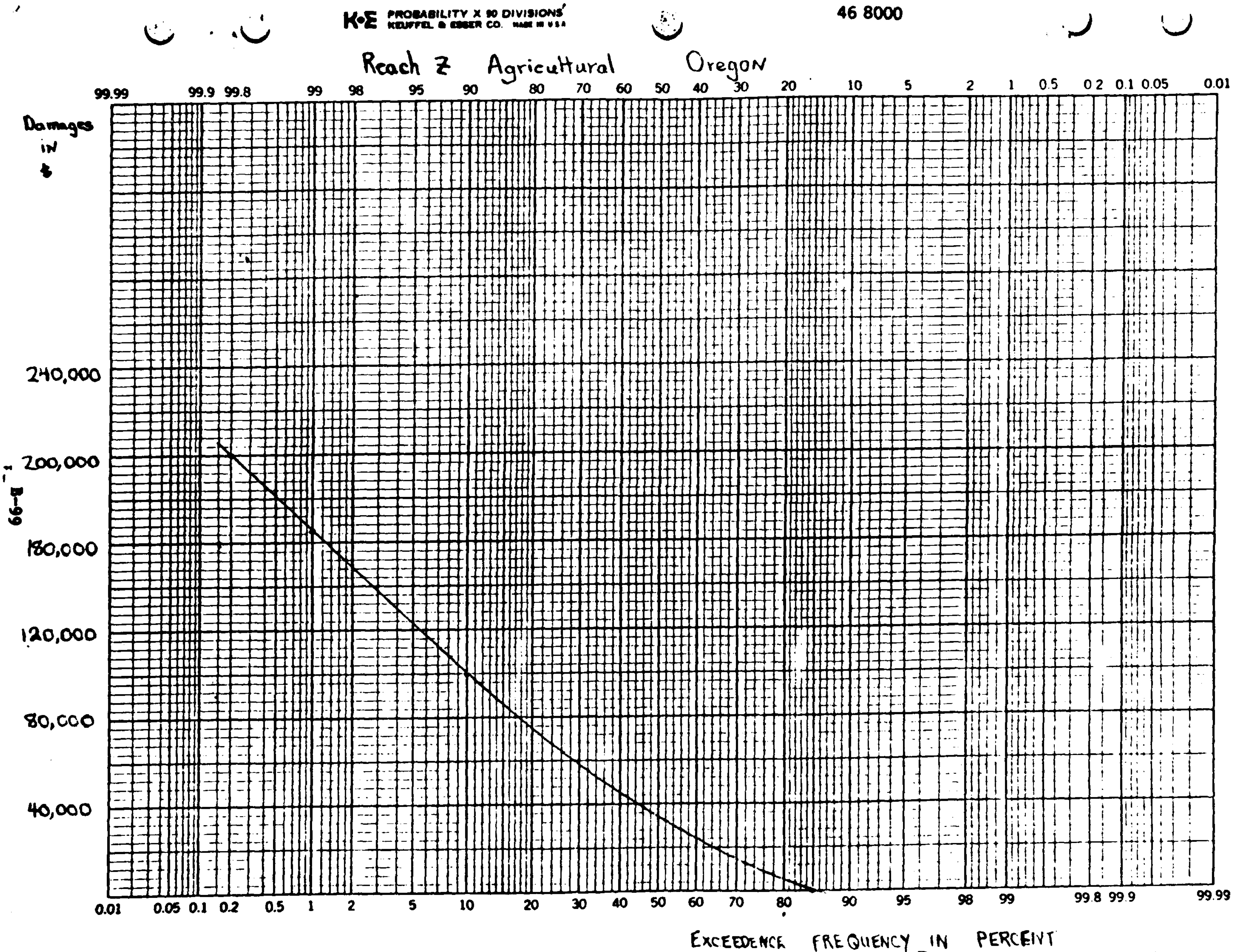

AUG 77
ATF
LAKE LEVELS WITH WAVES
INSTANTANEOUS LAKE LEVELS
ELEVATION IN FEET - I.G.L.D.
579
578
577
576
575
574
573
572
EXCEEDENCE FREQUENCY
LAKE ERIE AT PORT CLINTON, SAND BEACH, LONG BEACH, AND LOCUST POINT, OHIO
STAGE-FREQUENCY CURVES WITH & WITHOUT WAVE ACTION

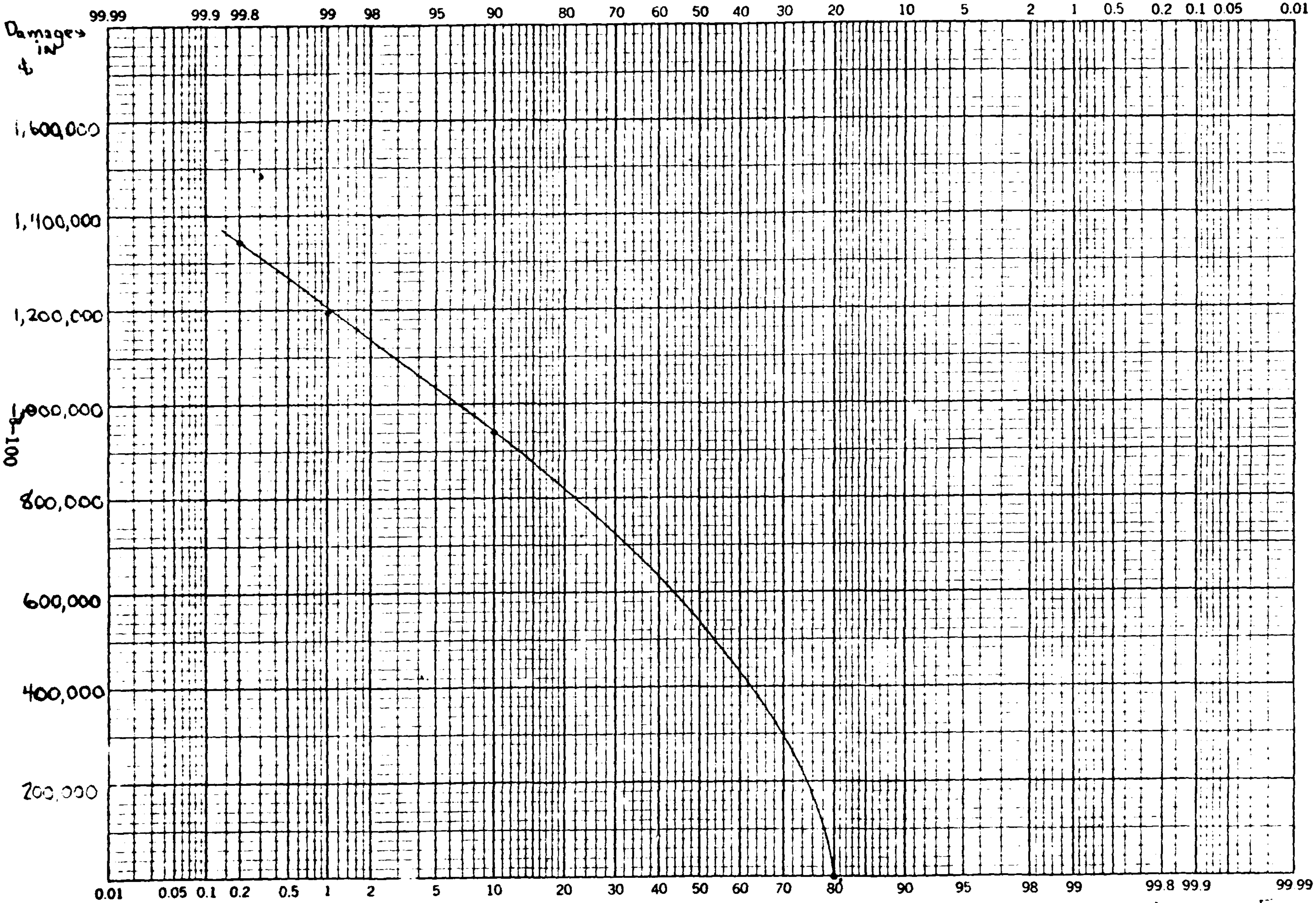
Plate B13

Reach 2 Agricultural Oregon



Damage-Frequency Curve PLATE B14

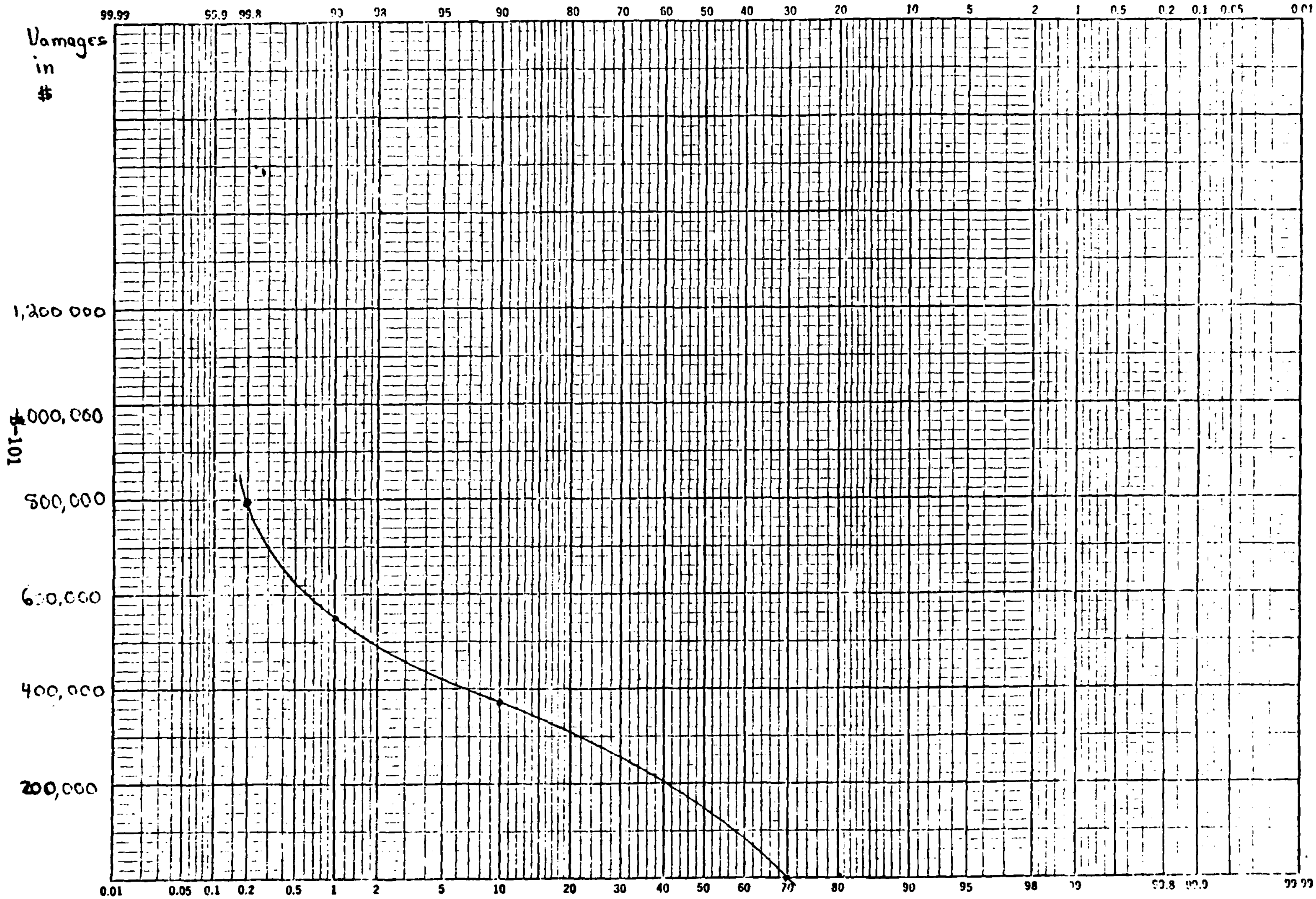
Reach Y Agricultural Lucas County, Ottawa County



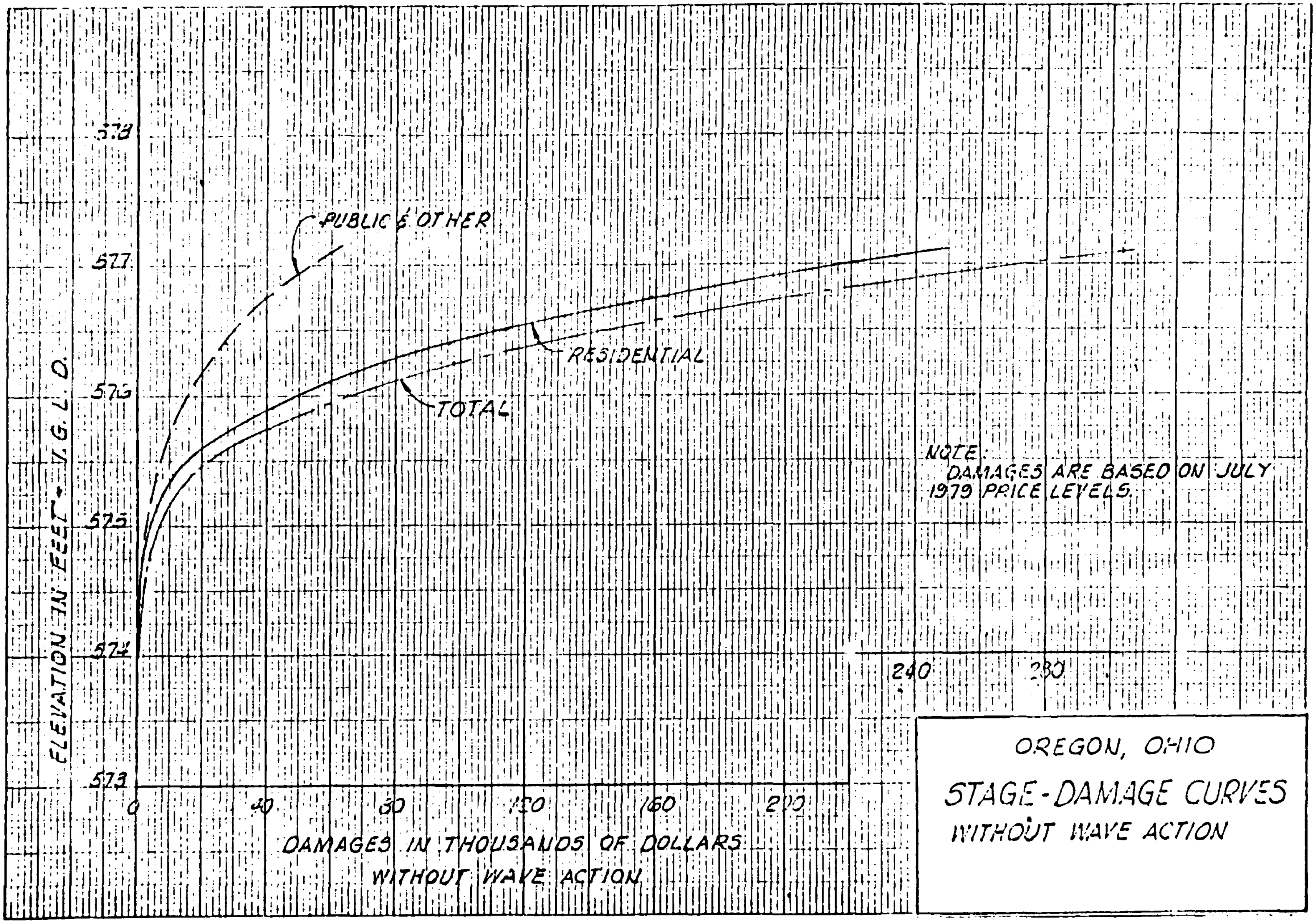
Damage-Frequency Curve
PLATE B15

K•E PROBABILITY X 90 DIVISIONS 46 8000 MADE IN U.S.A. KEUFFEL & ESSER CO.

Reach X Agricultural Port Clinton



Damage-Frequency Curve PLATE B16

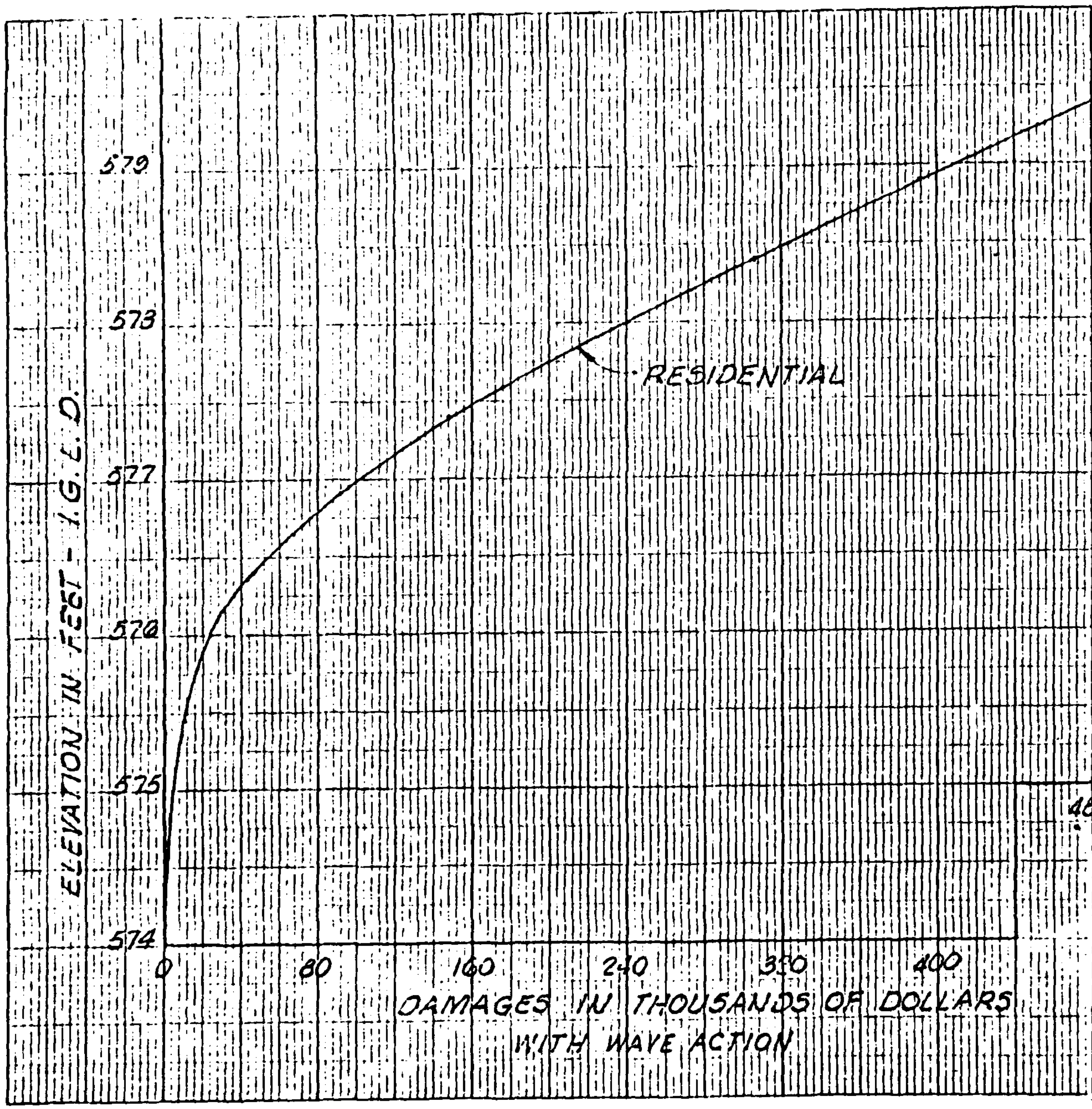


OREGON, OHIO

STAGE-DAMAGE CURVES

WITHOUT WAVE ACTION

PLATE B 17

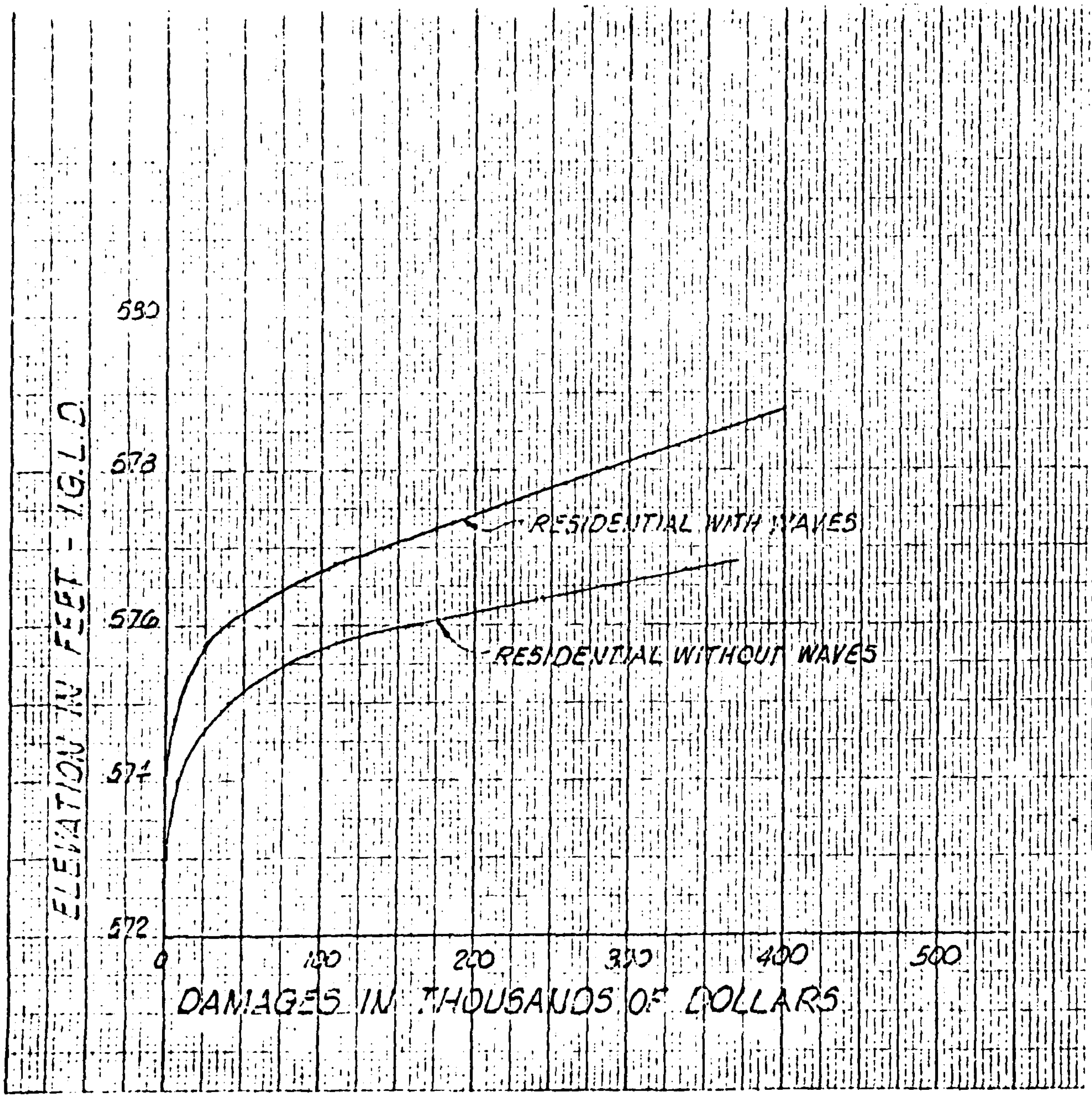


OREGON, OHIO

STAGE-DAMAGE CURVE

WITH WAVE ACTION

PLATE B18



NOTE:
DAMAGES ARE BASED ON FEB. 1981 PRICE LEVELS.

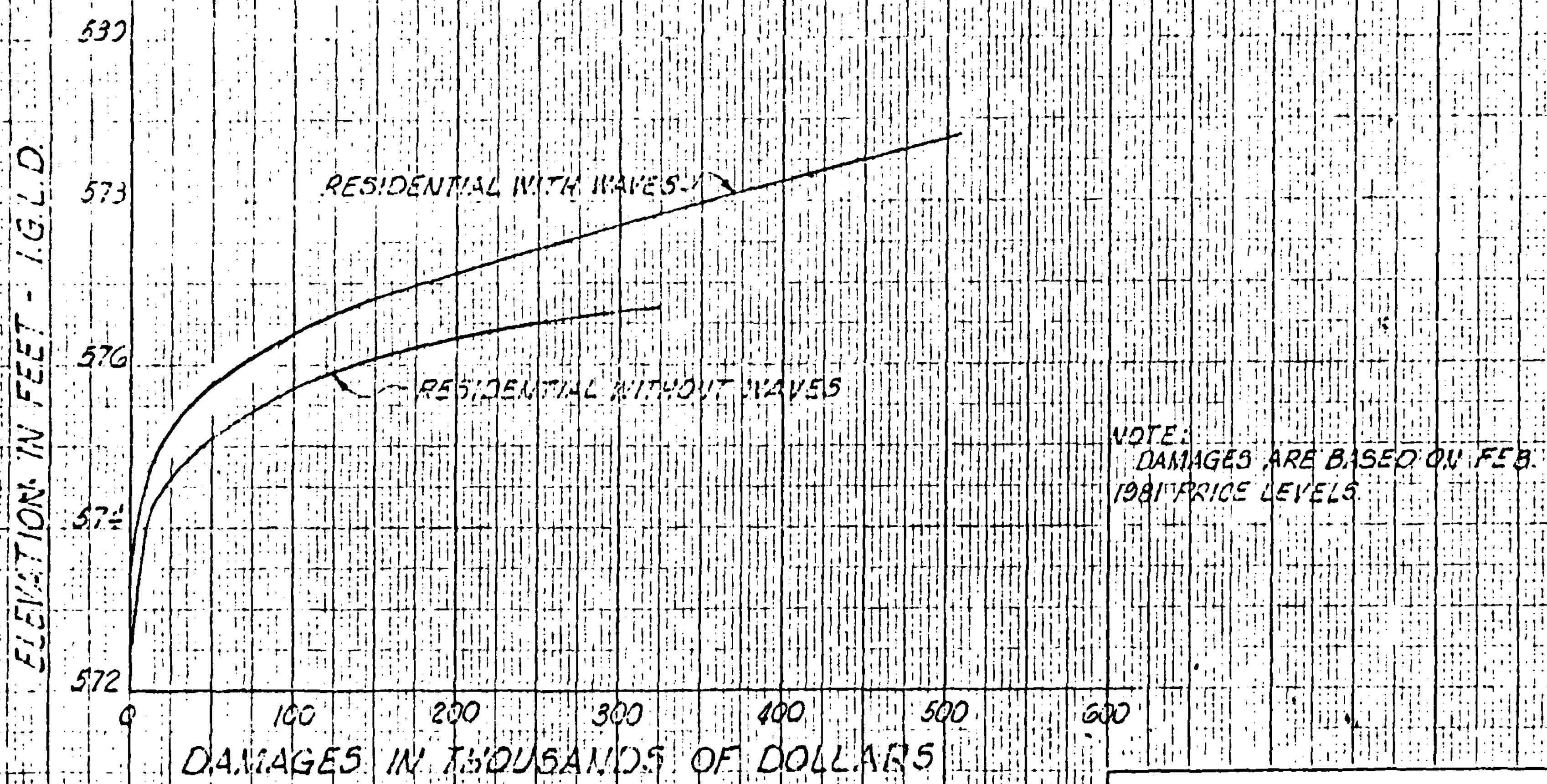
LOCUST POINT, OHIO

STAGE-DAMAGE CURVES

WITH & WITHOUT WAVE ACTION

PLATE B19

46 1240

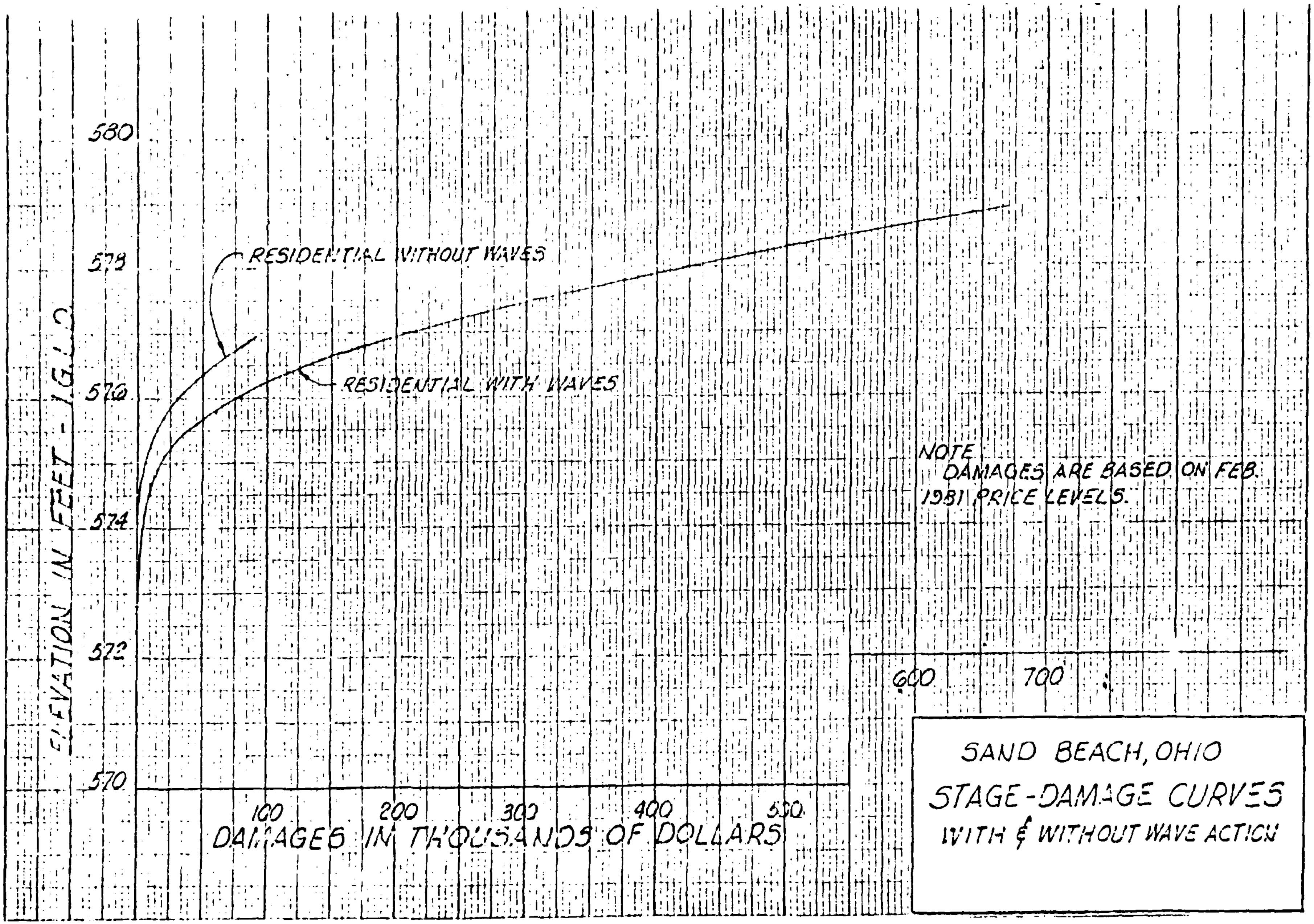


LONG BEACH, OHIO

STAGE-DAMAGE CURVES

WITH & WITHOUT WAVE ACTION

PLATE B20

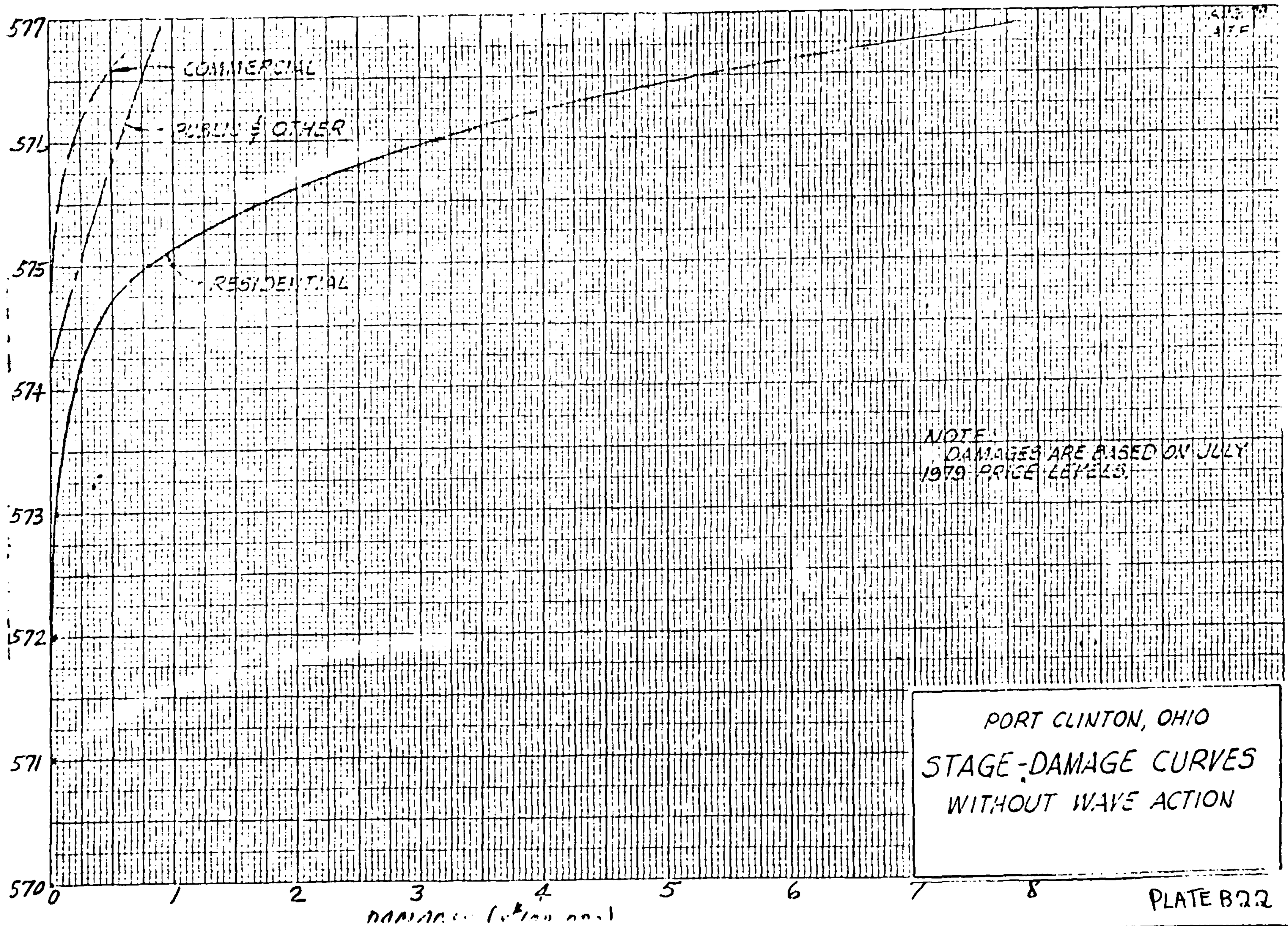


SAND BEACH, OHIO

STAGE-DAMAGE CURVES

WITH & WITHOUT WAVE ACTION

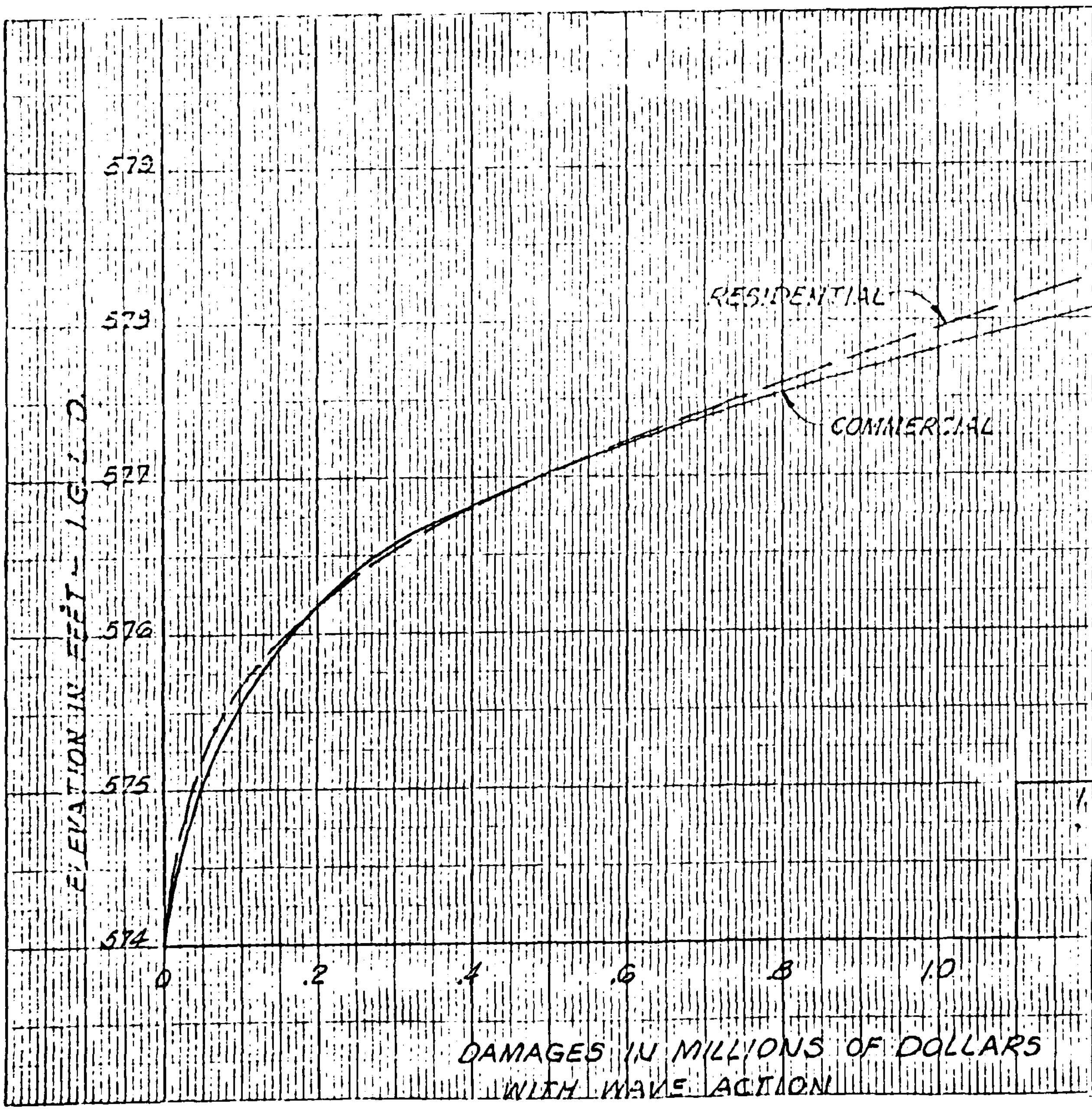
PLATE B21



PORT CLINTON, OHIO

STAGE - DAMAGE CURVES WITHOUT WAVE ACTION

PLATE B22



PORT CLINTON, OHIO

STAGE-DAMAGE CURVES

WITH WAVE ACTION

PLATE B23

City of Oregon - Aerial Photography

PLATE B24

APPENDIX C

COASTAL ENGINEERING STUDIES
AND
PRELIMINARY DESIGNS

BY D. K[illegible] DATE 11/14/80 SUBJECT WESTERN LAKE ERIE SHEET NO. 1 OF 15
CHKD. BY [illegible] DATE 11/20/80 SHORE - OREGON, OHIO AREA JOB NO.

WAVE ANALYSIS

IN ACCORDANCE WITH A 4 MAY 1976 GUIDANCE LETTER PROVIDED BY NCBED-H FOR USE OF WES TECHNICAL REPORT H76-1, FOR COASTAL PROJECTS HAVING A 50-YEAR DESIGN ECONOMIC LIFETIME, A COMBINED LAKE LEVEL AND DEEPWATER WAVE CORRESPONDING TO A 200-YEAR RECURRANCE EVENT IS RECOMMENDED. A 10-YEAR WAVE RECURRANCE INTERVAL WITH A 20-YEAR RECURRANCE DESIGN LAKE LEVEL WERE USED TO ANALYZE THE WAVE CONDITIONS WHICH CAN BE EXPECTED TO OCCUR AT THE PROJECT SITE.

DESIGN WATER LEVEL

THE DESIGN WATER LEVEL IS A COMBINATION OF THE JOINT OCCURENCE OF LONG-TERM AVERAGE LAKE LEVEL WITH A SHORT-TERM RISE DUE TO A STORM SETUP. THE 20-YEAR RECURRENCE WATER LEVEL WILL BE USED IN THIS DESIGN AND IS DETERMINED BY COMBINATION OF A 20-YEAR LAKE LEVEL WITH A 1-YEAR SHORT-TERM RISE. THE FREQUENCY CURVE FOR THE SECOND QUARTER MEAN LEVEL OF LAKE ERIE IS SHOWN IN FIGURE A-1 AND IN THAT A SECOND QUARTER MEAN LEVEL OF 573.0 FEET OCCURS ONCE IN 20-YEARS. THE FREQUENCY CURVE FOR SECOND QUARTER PEAK RISE AT TOLEDO, OHIO WILL BE USED IN THIS ANALYSIS AND INDICATES THAT A SHORT-TERM RISE OF 1.25 FEET CAN OCCUR EACH SPRING (SEE FIGURE A-2). COMBINING THE SECOND QUARTER LEVEL FOR LAKE ERIE WHICH HAS A 20-YEAR RECURRANCE WITH A SHORT-TERM FLUCTUATION THAT HAS A ONE YEAR RECURRANCE, YIELDS A 20-YEAR RECURRANCE DESIGN LAKE LEVEL.

SECOND QUARTER MEAN LEVEL FOR LAKE ERIE :	573.0
SECOND QUARTER PEAK RISE AT TOLEDO, OH :	1.3
20-YEAR DESIGN WATER LEVEL: (DWL)	574.3

THE FREQUENCY CURVES WERE OBTAINED FROM THE "STANDARDIZED FREQUENCY CURVES FOR DESIGN WATER LEVEL DETERMINATION ON THE GREAT LAKES."

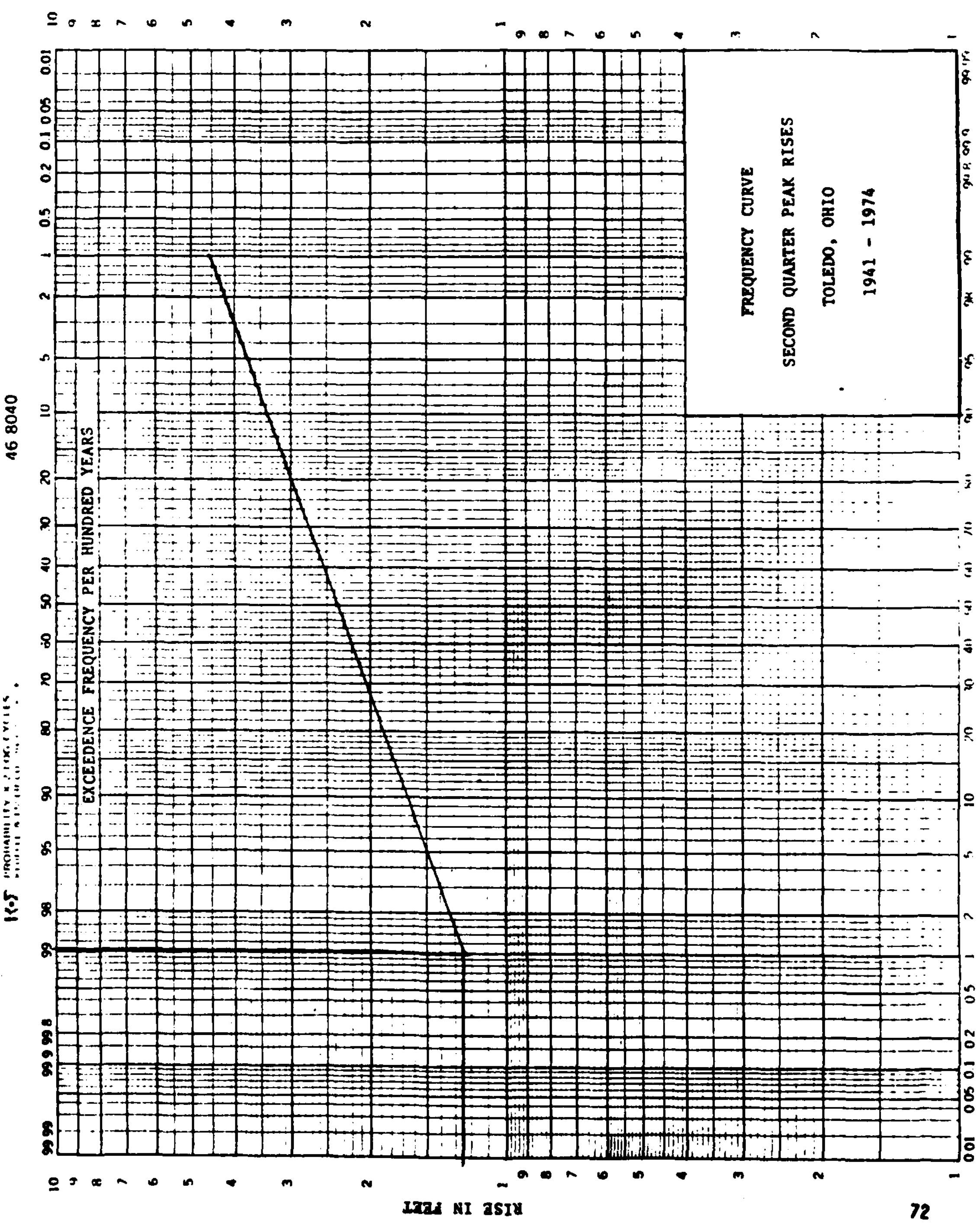

FREQUENCY CURVE
SECOND QUARTER PEAK RISES
TOLEDO, OHIO
1941 - 1974
EXCEEDENCE FREQUENCY PER HUNDRED YEARS
RISE IN FEET
46 8040

FIGURE A-1

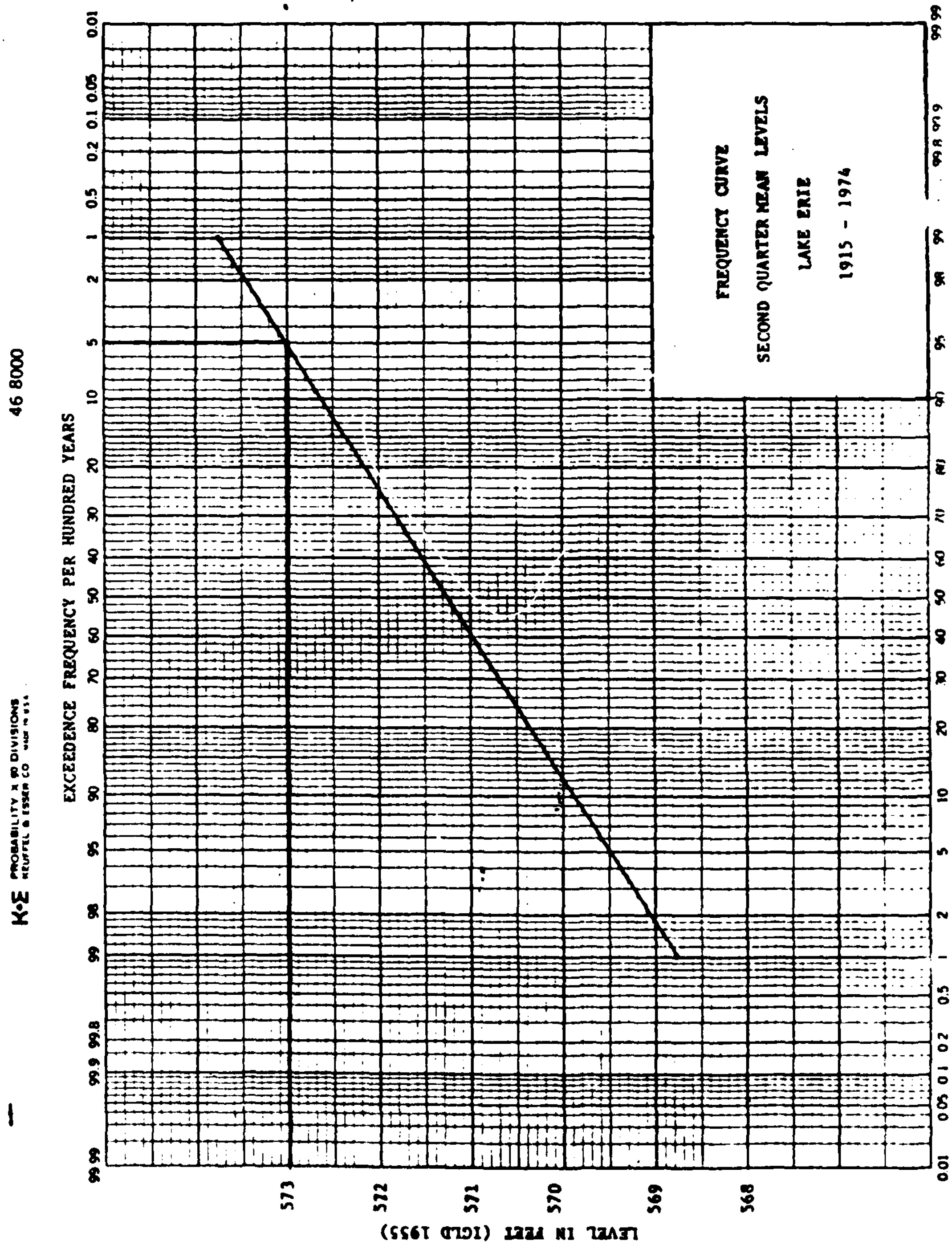

FREQUENCY CURVE
SECOND QUARTER MEAN LEVELS
LAKE ERIE
1915 - 1974
EXCEEDENCE FREQUENCY PER HUNDRED YEARS
LEVEL IN FEET (IGLD 1955)
573
572
571
570
569
568
K·E PROBABILITY X 90 DIVISIONS
KEUFFEL & ESSER CO.
46 8000

FIGURE A-2

DESIGN WAVES

THE SIGNIFICANT DEEP WATER WAVE HEIGHTS AND ASSOCIATED PERIODS WHICH COULD BE EXPECTED AT CEDAR POINT, OHIO WERE DETERMINED BY WATERWAYS EXPERIMENT STATION AND PUBLISHED IN TECHNICAL REPORT H-76-1, "DESIGN WAVE INFORMATION FOR THE GREAT LAKES", REPORT 1 DATED JANUARY 1976. TABLES A-1 AND A-2 SHOW THE SIGNIFICANT DEEP WATER WAVE HEIGHTS AND ASSOCIATED PERIODS AT CEDAR POINT, OH FOR THREE ANGLE CLASSES AND FOR EACH SEASON OF THE YEAR FOR VARIOUS RECURRENCE INTERVALS. FROM TABLE A-1, THE 10-YEAR SIGNIFICANT DEEP WATER WAVE FROM ANGLE CLASS 2 FOR THE SPRING SEASON WILL BE USED IN THIS ANALYSIS.

REVETMENT DESIGN

THE DATA REQUIRED FOR THE DESIGN OF THE REVETMENT IS AS FOLLOWS:

DEEP WATER WAVE HEIGHT (H_o) - 8.2 FEET

PERIOD (T) - 6.8 SECONDS

DESIGN WATER LEVEL - 574.3'

ELEVATION AT BOTTOM CONTOUR AT LOCATION OF STRUCTURE - 570.0'

DESIGN WATER DEPTH $(d_s) = 574.3' - 570.0 = 4.3'$

ASSUME A REFRACTION COEFFICIENT OF 1.0 AND SLOPE(m) = 1:100

THE METHOD DEVELOPED BY GODA FOR PREDICTING NEARSHORE IRREGULAR WAVE CONDITIONS WAS USED IN THIS ANALYSIS.

$$H_o' = H_o K_R = (8.2\text{FT})(1.0) = 8.2\text{ FT.}$$

$$L_o = 5.12T^2 = 5.12(6.8)^2 = 236.7 \text{ FEET}$$

$$\frac{H_o'}{L_o} = \frac{8.2}{236.7} = .03$$

$$\frac{d}{H_o'} = \frac{4.3}{8.2} = .52$$

TABLE A-1 - SIGNIFICANT DEEP WATER WAVE HEIGHTS AT CEDAR POINT, OHIO

~~Table E1 (Continued)~~

TABLE OF EXTREMES ESTIMATES
GRID LOCATION 10, 2 LAT=41.72 LON=83.27 CEDAR POINT OH
SHORELINE GRID POINT 2

WINTER
ANGLE CLASSES

	1	2	3	ALL
5	4.9(0.6)	5.9(1.1)	3.9(0.5)	7.4(1.1)
10	6.6(0.8)	8.2(1.5)	5.2(0.6)	9.3(1.5)
20	8.2(1.0)	9.2(1.8)	6.6(0.8)	11.2(1.9)
50	10.2(1.2)	12.5(2.3)	7.9(1.0)	13.9(2.4)
100	11.5(1.4)	14.8(2.6)	11.2(1.1)	16.0(2.7)

SPRING
ANGLE CLASSES

	1	2	3	ALL
5	4.9(0.3)	6.2(0.6)	3.0(0.3)	7.7(0.6)
10	6.2(0.3)	8.2(0.8)	4.3(0.4)	9.2(0.8)
20	7.5(0.4)	9.8(1.0)	4.9(0.6)	10.7(1.0)
50	7.9(0.5)	10.8(1.2)	6.6(0.7)	12.7(1.3)
100	9.8(0.6)	13.4(1.4)	10.2(0.8)	14.4(1.5)

SUMMER
ANGLE CLASSES

	1	2	3	ALL
5	3.9(0.2)	4.9(0.3)	2.3(0.3)	4.4(0.3)
10	4.3(0.3)	5.2(0.3)	2.6(0.4)	5.4(0.4)
20	4.9(0.4)	5.6(0.4)	3.0(0.5)	6.4(0.5)
50	5.6(0.5)	6.9(0.5)	4.6(0.6)	7.8(0.6)
100	6.6(0.5)	8.5(0.6)	5.2(0.7)	8.9(0.7)

FALL
ANGLE CLASSES

	1	2	3	ALL
5	5.6(0.4)	5.6(0.7)	4.3(0.4)	7.8(0.7)
10	7.9(0.5)	7.5(0.9)	5.2(0.5)	9.3(1.0)
20	8.5(0.6)	9.5(1.2)	5.9(0.7)	10.9(1.2)
50	10.5(0.7)	12.1(1.4)	8.5(0.8)	13.1(1.5)
100	11.5(0.9)	13.8(1.7)	9.8(0.9)	14.8(1.7)

(Continued)

(Sheet 2 of 24)

TABLE A-2 - SIGNIFICANT DEEPWATER [illegible]
WAVE PERIODS AT CEDAR POINT, OHIO

~~Table E3 (Continued)~~

GRID LOCATION 10, 2 LAT=41.72 LON=83.27 CEDAR POINT OH

GRID POINT NUMBER 2

SIGNIFICANT PERIOD BY ANGLE CLASS AND WAVE HEIGHT

WAVE HEIGHT (FT)	ANGLE CLASS 1	2	3
1	2.5	2.5	2.3
2	3.6	3.7	3.3
3	4.7	4.8	4.0
4	5.4	5.5	4.4
5	5.7	5.8	4.7
6	6.0	6.1	4.9
7	6.3	6.4	5.2
8	6.6	6.8	5.4
8.2		6.8	
9	6.9	7.1	5.6
10	7.2	7.4	5.9
11	7.4	7.7	6.1
12	7.7	8.0	6.3
13	8.0	8.4	6.5
14	8.3	8.7	6.8
15	8.6	9.0	7.0
16	8.9	9.3	7.2
17	9.2	9.6	7.5
18	9.5	10.0	7.7
19	9.8	10.3	7.9
20	10.1	10.6	8.1
21	10.3	10.9	8.4
22	10.6	11.2	8.6
23	10.9	11.6	8.8
24	11.2	11.9	9.1
25	11.5	12.2	9.3

(Continued)

(Sheet 2 of 24)

FROM GODA CURVES ; SLOPE = 1/100 :

$\frac{H_o'}{L_o} = .02 \qquad \frac{H_{max}}{H_o'} = .50$ (GODA GRAPH 1)

$\frac{H_o'}{L_o} = .03 \qquad \frac{H_{max}}{H_o'} = .49$ (INTERPOLATED)

$\frac{H_o'}{L_o} = .04 \qquad \frac{H_{max}}{H_o'} = .47$ (GODA GRAPH 2)

$H_{MAX} = .49(H_o') = .49(8.2) = 4.02$ FEET

ASSUME A BREAKING WAVE FOR DESIGN PURPOSES. THE REVETMENT WILL BE DESIGNED WITH A 1:2 LAKEWARD SLOPE AND 1:2 BACKSLOPE. THE REVETMENT WILL BE CONSTRUCTED OF COMPACTED CLAY WITH A STONE ARMOR FACE TO PROTECT THE CLAY DIKE. THE STONE WILL BE ROUGH ANGULAR QUARRYSTONE PLACED RANDOMLY. THE ARMOR UNIT STABILITY COEFFICIENT (K_D) WILL BE THAT FO[R] A STRUCTURE TRUNK. THE ARMOR STONE WILL BE PLACED ON A FILTER CLOTH.

STONE WEIGHT

$$W = \frac{W_r (H_{MAX})^3}{K_D (S_r - 1)^3 \cot\theta}$$

WHERE $W_r = 158$ LB/FT^3

$H_{MAX} = 4.0'$

$S_r = \frac{W_r}{W_w} = \frac{158}{62.4} = 2.53$

$\cot\theta = 2.0$

$K_D = 3.5$

$$W = \frac{158(4.0)^3}{(3.5)(2.53-1)^3(2.0)} = 403.3 \text{ LB}$$

ARMOR STONE

$W_{MAX} = 2.0W = 2.0(403.3) = 806.7$ LB

$W_{MIN} = 0.9W = 0.9(403.3) = 363.0$ LB

THE WEIGHT OF THE ARMOR STONE REQUIRED RANGES FROM 806.7 LB. TO 363.0 LB. STANDARD SLAG COMPANY QUA[RRY] AT MARBLEHEAD, OHIO PRODUCES A STANDARD ITEM WHICH MEETS THIS REQUIREMENT. THE STONE AVAILABLE IS AS FOLLOWS:

STANDARD SLAG 15-19" ITEM

WEIGHT	% PASSING
1200 #	100
1000	95
800	86
600	78
400	57
200	23
100	14
80	12
50	9

THICKNESS OF ARMOR LAYER

$$r = n k_\Delta \left(\frac{W}{W_r}\right)^{1/3}$$

WHERE $n = 2.0$ LAYERS

$k_\Delta = 1.15$

$W = 403.3$ LB

$W_r = 158$

$$r = (2)(1.15)\left(\frac{403.3}{158}\right)^{1/3}$$

$$r = 3.1 \sim 3 \text{ FT}$$

CREST HEIGHT

THE REVETMENT WILL BE DESIGNED FOR ZERO OVERTOPPING.

$H_o = 8.2$ FEET

$T = 6.8$ SECONDS

$m = 1:100$

$k_R = 1.0$ (ASSUMED)

$d_s = 4.3$ FEET

$$H_o' = H_o k_R = (8.2')(1.0) = 8.2'$$

$$\frac{H_o'}{gT^2} = \frac{8.2}{(32.2)(6.8)^2} = .0055$$

$$\frac{d_s}{H_o'} = \frac{4.3}{8.2} = .52$$

BY L. ROWEN DATE 11/14/80	SUBJECT WESTERN LAKE ERIE SHORE	SHEET NO. 9 OF 15
CHKD. BY [illegible] DATE 11/20/80	OREGON, OHIO AREA	JOB NO.

$\frac{d_s}{H_o'} = .45 \qquad \frac{R}{H_o'} = 1.55$ (FROM FIGURE 7-9 OF SPM)

$\frac{d_s}{H_o'} = .52 \qquad \frac{R}{H_o'} = 1.71$ (INTERPOLATED)

$\frac{d_s}{H_o'} = .80 \qquad \frac{R}{H_o'} = 2.35$ (FROM FIGURE 7-10 OF SPM)

$R = 1.71 H_o' = 1.71(8.2) = 14.0'$

CORRECTION FOR MODEL SCALE EFFECT

K - SCALE CORRECTION FACTOR (SPM FIGURE 7-13)

$m = \tan\theta = .5$

$K = 1.15$

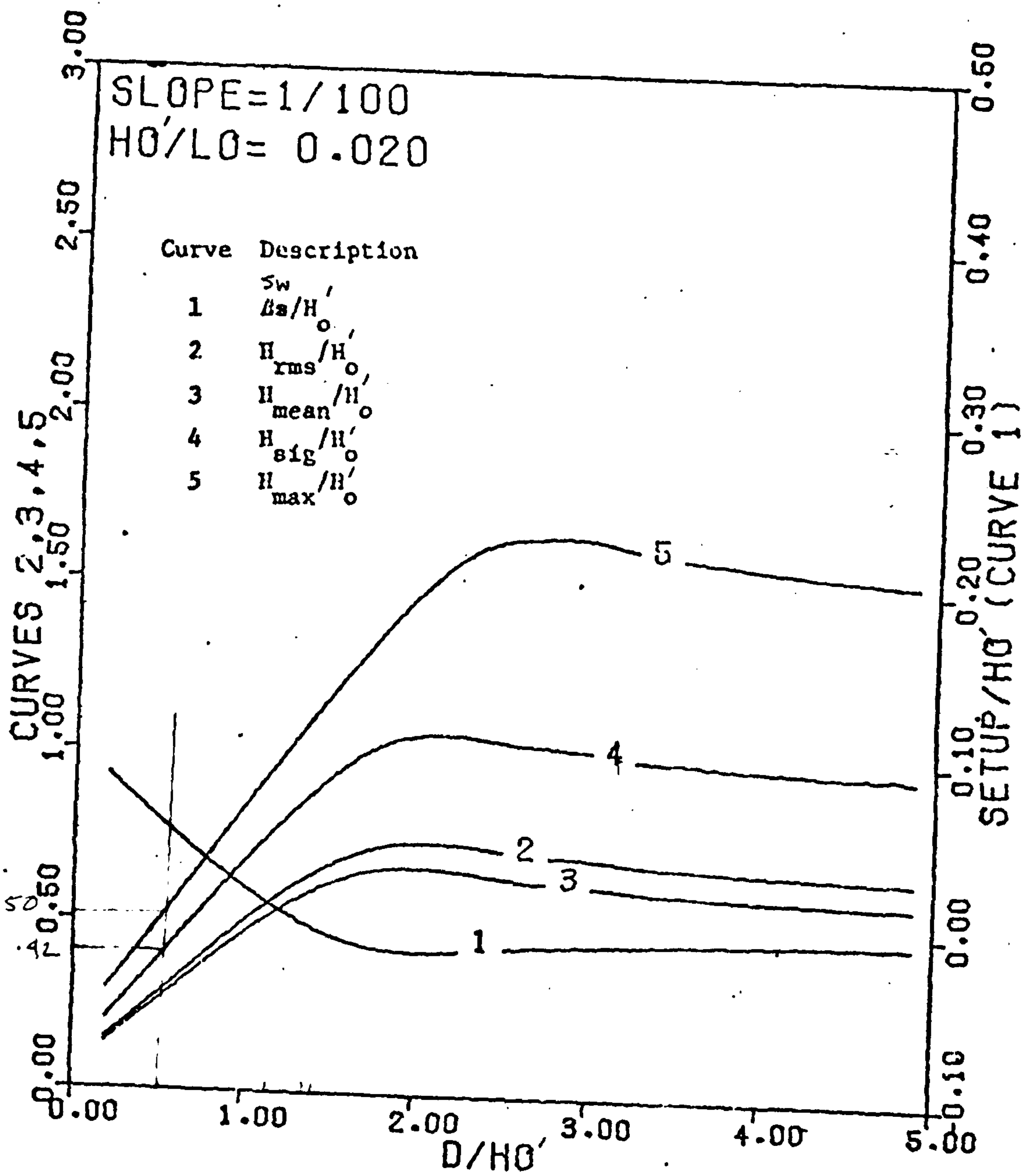
CORRECTED RUNUP - SMOOTH IMPERMEABLE STRUCTURE:

$R = 14.0(1.15) = 16.1$

THIS RUNUP IS OVERESTIMATED DUE TO THE FACT THAT FIGURES 7-8 THROUGH 7-12, AND 7-14 THROUGH 7-18 OF SPM ARE FROM TESTS WITH 1:10 SLOPE, WHEREAS THE ACTUAL BEACH SLOPE IS LESS IN MOST CASES. TO REMEDY THIS DISCREPENCY, WE USE GODA'S CHARTS TO CALCULATE THE WAVE HEIGHTS AT THE STRUCTURE FOR THE 1:10 LAKEBED SLOPE AND FOR THE LESSER BEACH SLOPE. THE H_{s16}/H_o' FOR THE DESIGN SLOPE OF 1:100 WAS COMPUTED USING PROGRAM GODA 2.

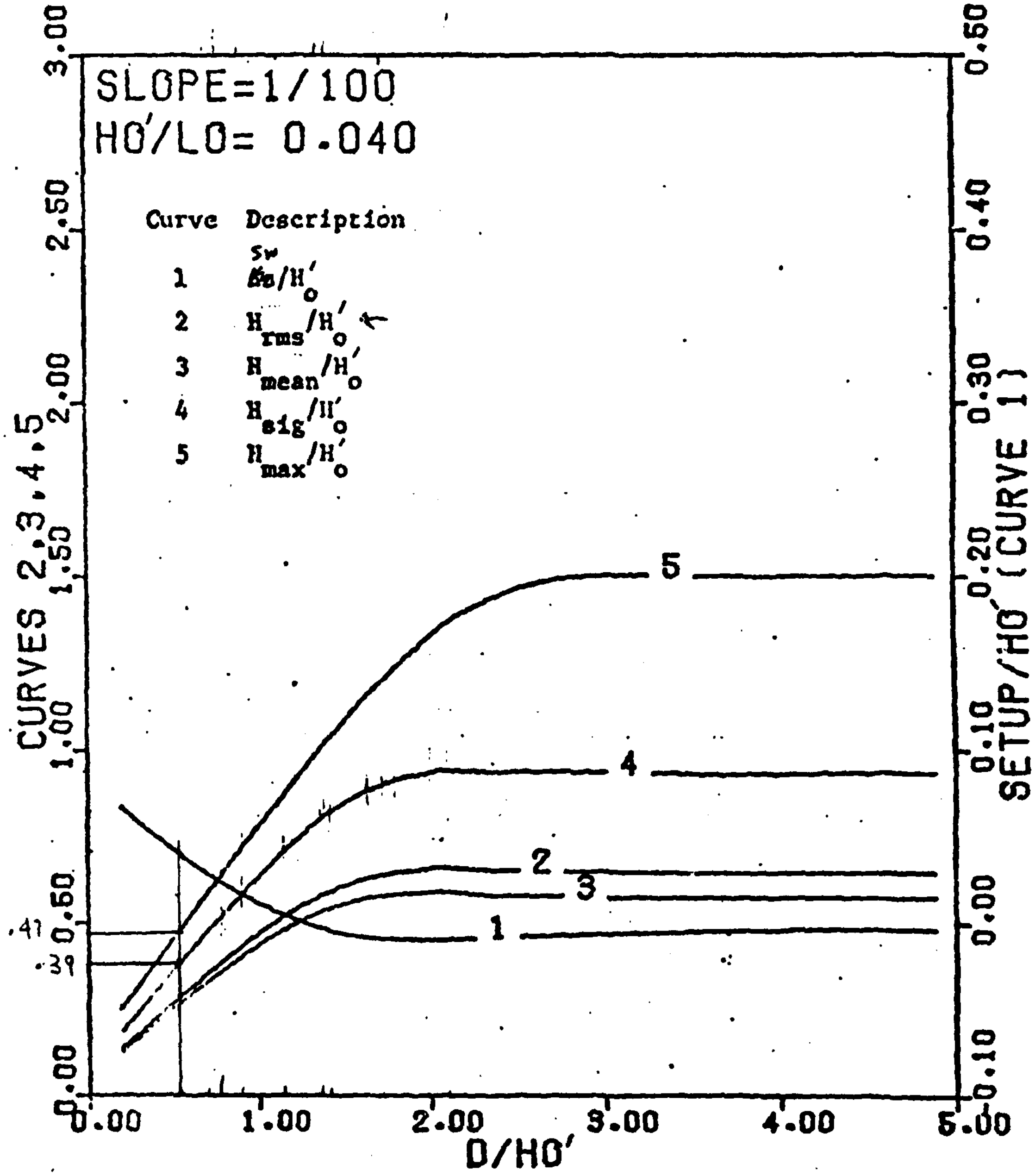
GODA CORRECTION

1:100 SLOPE		1:10 SLOPE	
$\frac{d_s}{H_o'} = .52 \quad \frac{H_o'}{L_o} = .03$		$\frac{d_s}{H_o'} = .52 \quad \frac{H_o'}{L_o} = .03$	
$\frac{H_o'}{L_o} = .02$	$\frac{H_{s16}}{H_o'} = .42$ (GODA GRAPH 1)	$\frac{H_o'}{L_o} = .02$	$\frac{H_{s16}}{H_o'} = .66$ (GODA GRAPH 3)
$\frac{H_o'}{L_o} = .03$	$\frac{H_{s16}}{H_o'} = .41$ (INTERPOLATED)	$\frac{H_o'}{L_o} = .03$	$\frac{H_{s16}}{H_o'} = .63$ (INTERPOLA
$\frac{H_o'}{L_o} = .04$	$\frac{H_{s16}}{H_o'} = .39$ (GODA GRAPH 2)	$\frac{H_o'}{L_o} = .04$	$\frac{H_{s16}}{H_o'} = .59$ (GODA GRAPH 4)



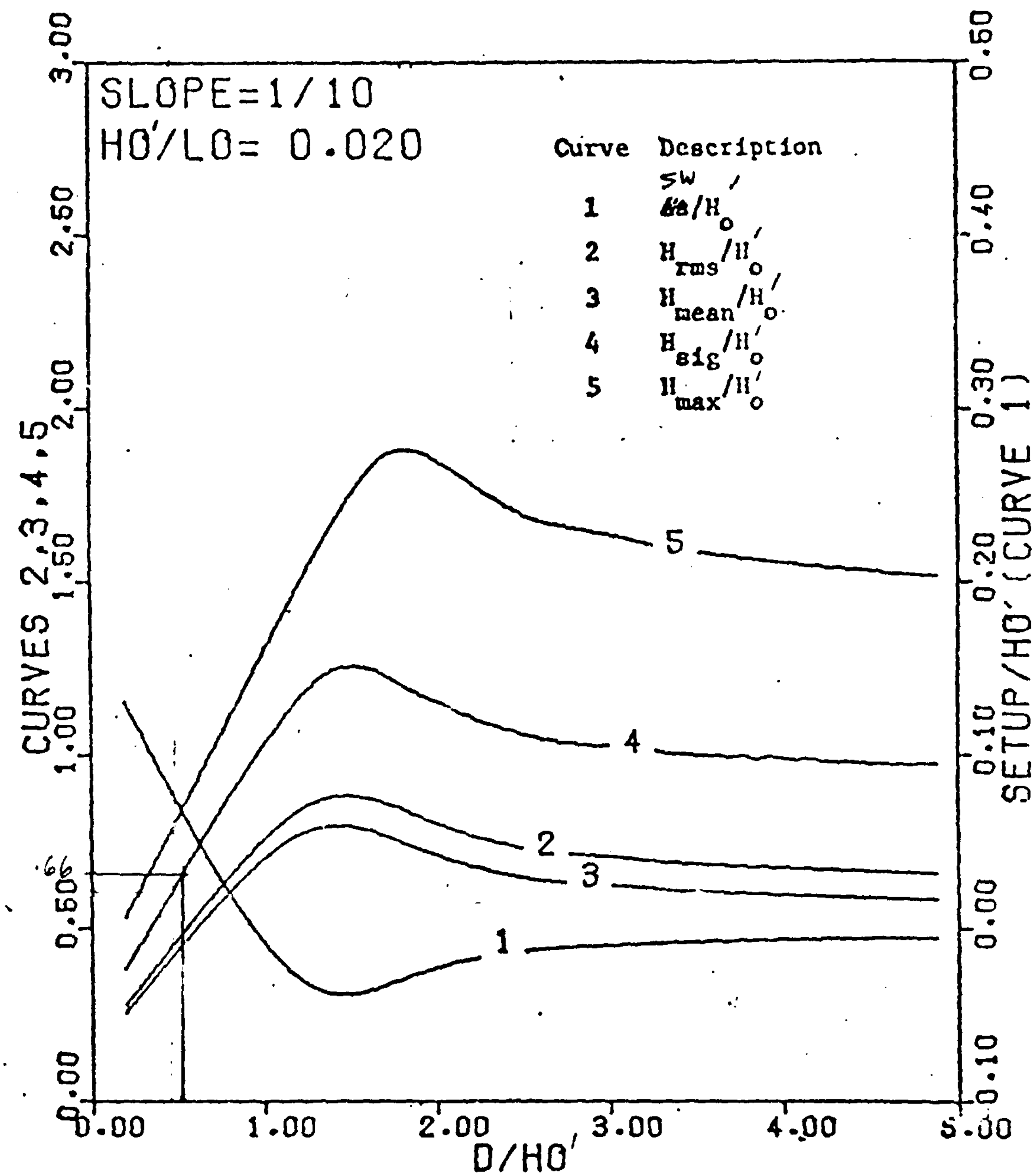
SLOPE=1/100
HO'/LO= 0.020
Curve Description
1 Sw/H'o
2 Hrms/H'o
3 Hmean/H'o
4 Hsig/H'o
5 Hmax/H'o
CURVES 2,3,4,5
SETUP/HO' (CURVE 1)
D/HO'
0.00
0.50
1.00
1.50
2.00
2.50
3.00
1.00
2.00
3.00
4.00
5.00
0.60
0.40
0.30
0.20
0.10
0.00
.50
.42
1
2
3
4
5

B-3

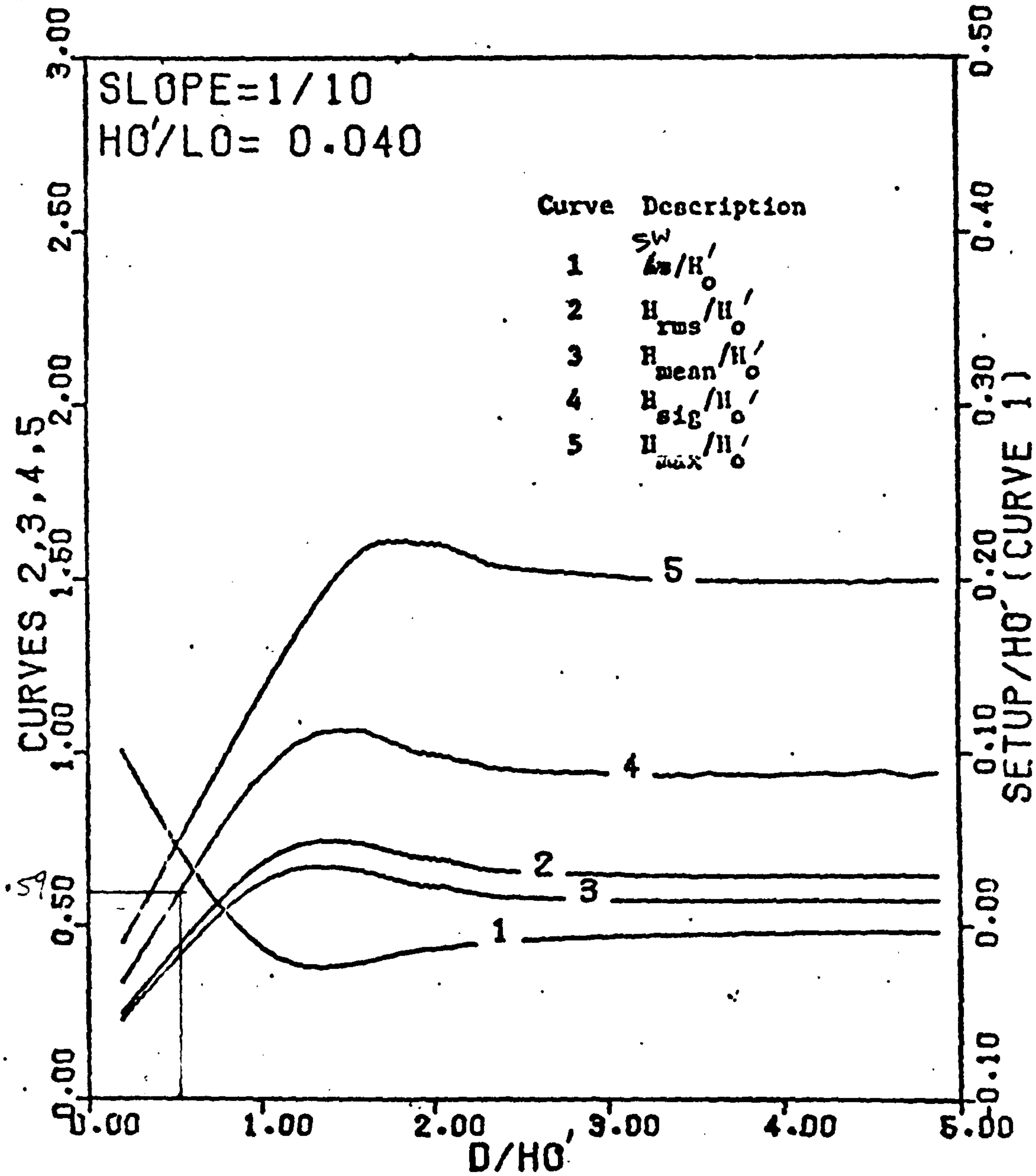


GODA GRAPH 2

B-2


SLOPE=1/10
HO'/LO= 0.020
Curve Description
1 SW/Ho'
2 Hrms/Ho'
3 Hmean/Ho'
4 Hsig/Ho'
5 Hmax/Ho'
CURVES 2,3,4,5
SETUP/HO' (CURVE 1)
D/HO'
.66
0.00
0.50
1.00
1.50
2.00
2.50
3.00
-0.10
0.00
0.10
0.20
0.30
0.40
0.50
1.00
2.00
3.00
4.00
5.00
1
2
3
4
5

GODA GRAPHS


SLOPE=1/10
HO'/LO= 0.040
Curve Description
1 η_{sw}/H_o'
2 H_{rms}/H_o'
3 H_{mean}/H_o'
4 H_{sig}/H_o'
5 H_{max}/H_o'
CURVES 2,3,4,5
SETUP/HO' (CURVE 1)
D/HO'
.59
0.00 0.50 1.00 1.50 2.00 2.50 3.00
0.00 1.00 2.00 3.00 4.00 5.00
-0.10 0.00 0.10 0.20 0.30 0.40 0.50
1 2 3 4 5

GODA GRAPH

$$\frac{\left(\frac{H_{SIG}}{H_o}\right)_{1:100}}{\left(\frac{H_{SIG}}{H_o}\right)_{1:10}} = \frac{.41}{.63} = .65$$

ACTUAL SMOOTH SURFACE RUNUP = (15.1')(.65) = 9.8

FROM CETA 79-1, APPENDIX A - ROUGH SLOPE RUNUP CORRECTION FACTOR FOR $d_s/H_o' < 3$ AND $\cot\theta = 2.0$ IS $r = 0.61$.

ACTUAL WAVE RUNUP = (9.8)(.61) = 6.0'

CREST ELEVATION = WATER ELEVATION + WAVE RUN UP HEIGHT
= 573.6' + 6.0'

CREST ELEVATION = 579.6 FEET

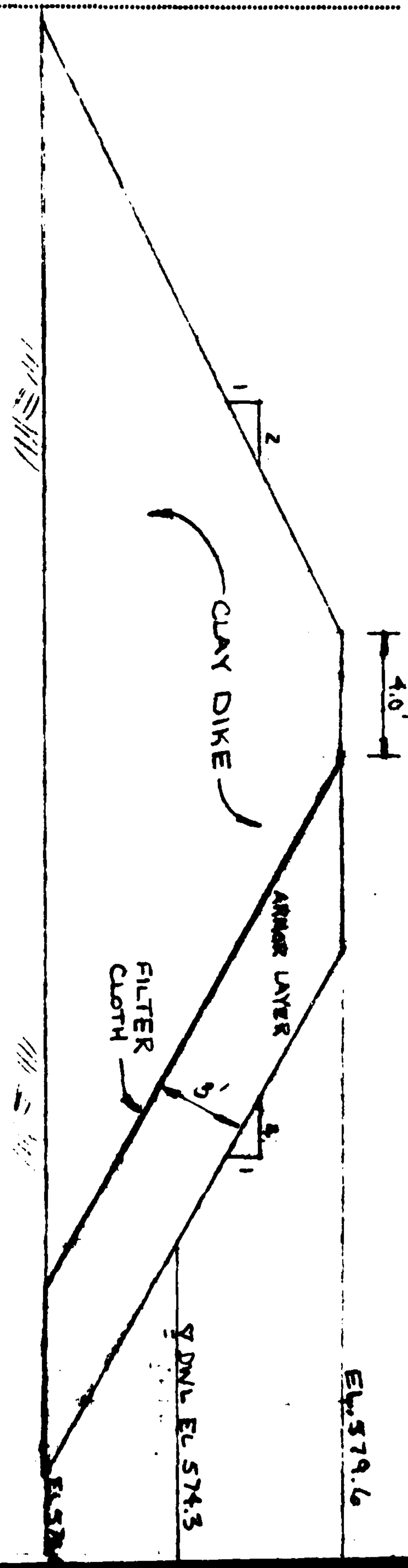
TYPICAL SECTIONS

A TYPICAL CROSS SECTION FOR THE AREA TO BE PROTECTED AT OREGON, OHIO IS SHOWN ON PLATE A-1.

BY D. KOWEN DATE 11/11/80 SUBJECT WESTERN LAKE ERIE SHORE OREGON, OHIO AREA SHEET NO. 15 OF 15

CHKD. BY .... DATE .... JOB NO. ....

WESTERN LAKE ERIE SHORE
OREGON, OHIO AREA



TYPICAL SECTION
FOR BOTTOM ELEVATION @ 570.0
SCALE: 1" = 5'

BY RJG DATE 11/10/80 SUBJECT Western Lake Erie Shore - Port Clinton, OH area SHEET NO. 1 OF 6
CHKD. BY [illegible] DATE [illegible] JOB NO.

WAVE ANALYSIS

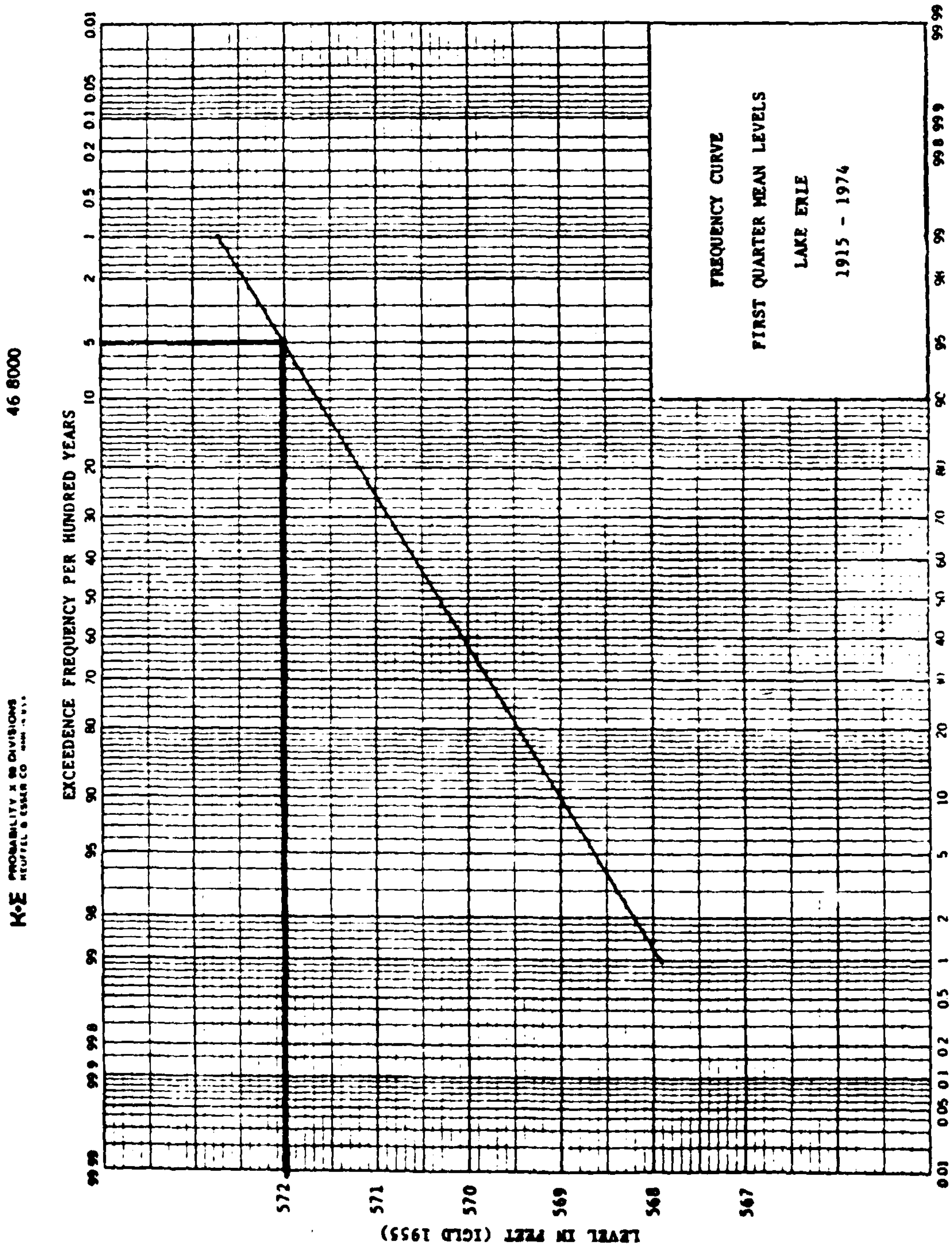
In accordance with a 4 May 1976 guidance letter provided by NCBED-H for use of WES Technical Report H-76-1, for coastal projects having a 50-year design economic lifetime, a combined lake level and deepwater wave corresponding to a 200-year recurrance event is recommended. A 10-year wave recurrance interval with a 20-year recurrance design lake level were used to analyze the wave conditions which can be expected to occur at the project site.

Design Water Level

The design water level is a combination of the joint occurrence of long-term average lake level with a short-term rise due to a storm setup. The 20-year recurrence water level will be used in this design and is determined by combination of a 20-year lake level with a 1-year short-term rise. The frequency curve for the first quarter mean level of Lake Erie is shown in Figure A-1 and indicates that a first quarter mean level of 572.0 feet occurs once in 20-years. The frequency curve for first quarter peak rise at Marblehead, OH will be used in this analysis and indicates that a short-term rise of 0.8 feet can occur each winter (see Figure A-2). Combining the first quarter level for Lake Erie which has a 20-year recurrance with a short term fluctuation that has a one year recurrance, yields a 20-year recurrance design lake level

first quarter mean level for Lake Erie	: 572.0
first quarter peak rise at Marblehead, OH	: 0.8
20-Year Design Water Level (DWL)	: 572.8

The frequency curves were obtained from the "Standardized Frequency Curves for Design Water Level Determination on the Great Lakes".



FREQUENCY CURVE
FIRST QUARTER MEAN LEVELS
LAKE ERIE
1915 - 1974
EXCEEDENCE FREQUENCY PER HUNDRED YEARS
LEVEL IN FEET (IGLD 1955)
572
571
570
569
568
567
46 8000
K+E

Figure A-1

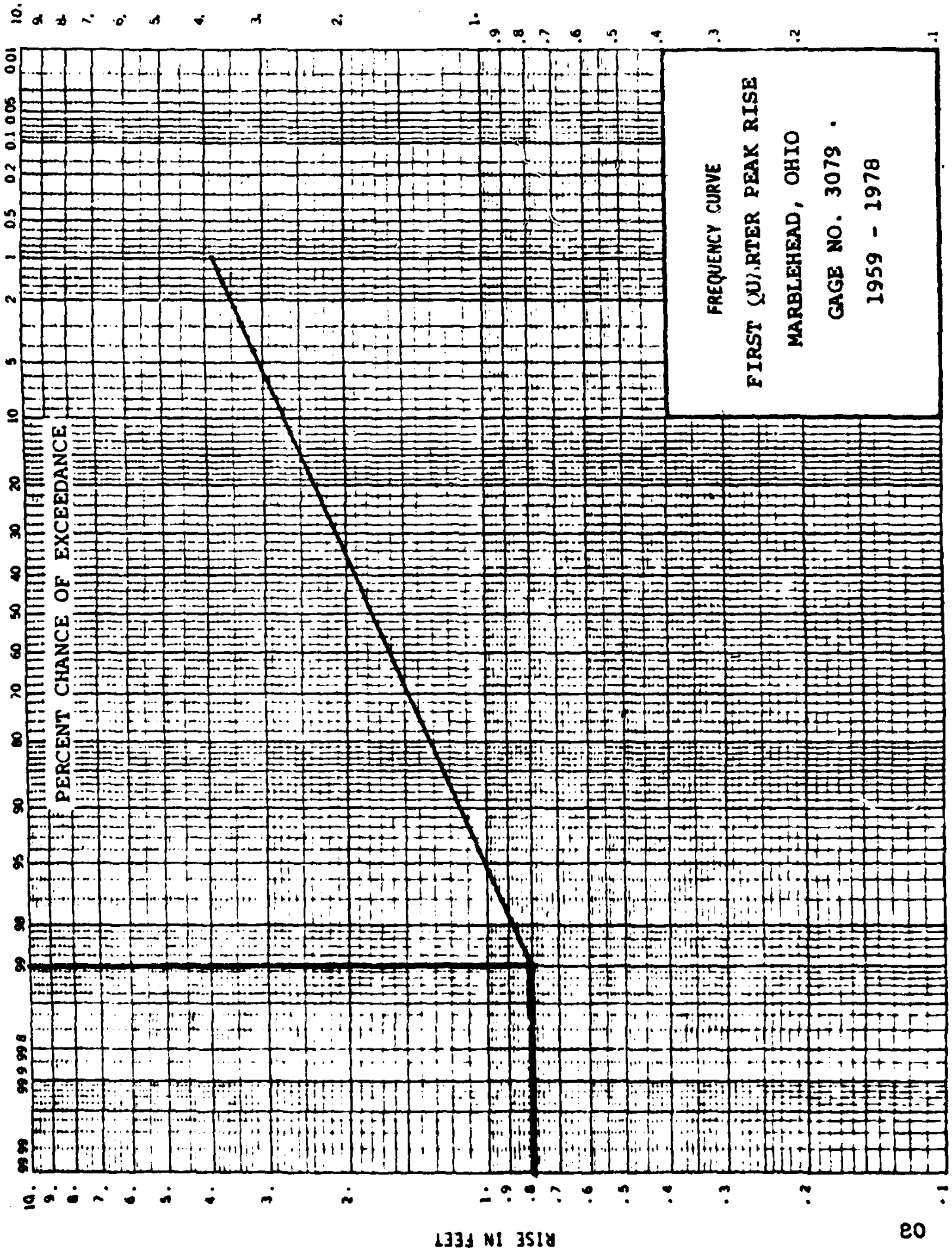

FREQUENCY CURVE
FIRST QUARTER PEAK RISE
MARBLEHEAD, OHIO
GAGE NO. 3079
1959 - 1978
PERCENT CHANCE OF EXCEEDANCE
RISE IN FEET

Figure A-2

Design Waves

The significant deep water wave heights and associated periods which could be expected at Port Clinton, OH were determined by Waterways Experiment Station and published in Technical Report H-76-1, "Design Wave Information for the Great Lakes," Report 1 dated January 1976. Tables A-1 and A-2 show the significant deep water wave heights and associated periods at Port Clinton, OH for three angle classes and for each season of the year for various recurrence intervals. From Table A-1, the 10-year significant deep water wave from angle class 2 for the winter season will be used in this analysis.

Revetment Design

The data required for the design of the revetment is as follows:

Deepwater Wave Height (H_o) = 9.5 feet
Period (T) = 7.0 seconds
Design Water level = 572.8
Bottom Contour at Location of Structure: 570.0
and : 575.0

Design Water Depth (d_s) = 572.8 - 570.0 = 2.8 ft.
Assume a Refraction Coefficient of 1.0 and m = 1:100

The method developed by Goda for predicting nearshore irregular wave conditions was used in this analysis.

$$H_o' = H_o k_R = (9.5)(1.0) = 9.5 \text{ feet}$$

$$L_o = 5.12 T^2 = (5.12)(7.0)^2 = 250.9 \text{ feet}$$

$$\frac{H_o'}{L_o} = \frac{9.5}{250.9} = 0.04$$

$$\frac{d}{H_o'} = \frac{2.8}{9.5} = 0.3$$

$$\frac{H_{max}}{H_o'} = 0.33 \quad \text{(from Goda Curves)}$$

$$H_{max} = 0.33(H_o') = (0.33)(9.5) = 3.1 \text{ feet}$$

Assume a breaking wave for design purposes. The revetment will be designed with a 1:2 lakeward slope and 1:20 backslope. The revetment will be constructed of compacted clay with a stone armor face to protect the clay dike. The stone will be rough angular quarrystone placed randomly. The armor unit stability coefficient (K_D) will be that for a structure trunk. The armor stone will be placed directly on top of filter cloth.

Stone Weight

$$W = \frac{W_r (H_{max})^3}{K_D (S_r - 1)^3 \cot\theta}$$

where $W_r = 158$ lb/ft^3
$H_{max} = 3.1$ feet
$S_r = \frac{W_r}{W_w} = \frac{158}{62.4} = 2.53$
$\cot\theta = 2.0$
$K_D = 3.5$

$$W = \frac{(158)(3.1)^3}{(3.5)(2.53-1)^3(2.0)}$$

$W = 188$ lbs

Armor Stone

$W_{max} = 2.0\,W = 2.0(188) = 376$ lbs

$W_{min} = 0.9\,W = 0.9(188) = 169$ lbs

The weight of the armor stone required ranges from 170 lbs to 400 lbs. The Standard Slag Company Quarry at Marblehead, OH produces a standard item which meets this requirement. The stone available is as follows:

Standard Slag 10"-15" item

#	% Passing
700	100
600	98
500	95
300	84
160	60
80	29
30	5

Thickness of Armor Layer

$r = n k_\Delta \left(\frac{W}{w_r}\right)^{1/3}$ where $n = 2.0$ layers

$r = (2)(1.15)\left(\frac{188}{158}\right)^{1/3}$ $k_\Delta = 1.15$

$r = 2.44$ feet $W = 188$ lbs

use 2.5 feet $w_r = 158$ lbs

Crest Height

The revetment will be designed for zero overtopping.

$H_o = 9.5$ feet

$T = 7.0$ seconds

$m = 1:100$

$K_R = 1.0$ (assumed)

$d_s = 2.8$ feet

$H_o' = H_o k_R = (9.5)(1.0) = 9.5$ feet

$$\frac{H_o'}{gT^2} = \frac{9.5}{(32.2)(7.0)^2} = 0.0060$$

$$\frac{d_s}{H_o'} = \frac{2.8}{9.5} = 0.30$$

$\frac{d_s}{H_o'} = 0$ $\frac{R}{H_o'} = 0.87$ (from Fig 7-8 of SPM)

$\frac{d_s}{H_o'} = 0.30$ $\frac{R}{H_o'} = 1.26$ (Interpolated Value)

$\frac{d_s}{H_o'} = 0.45$ $\frac{R}{H_o'} = 1.46$ (from Fig 7-9 of SPM)

TABLE A-1 – SIGNIFICANT DEEP WATER WAVE HEIGHTS AT PORT CLINTON, OHIO

TABLE OF EXTREMES ESTIMATES
GRID LOCATION 10, 4 LAT=41.69 LON=82.90 PORT CLINTON OH
SHORELINE GRID POINT 4

WINTER

	ANGLE CLASSES 1	2	3	ALL
5	4.3(0.3)	8.2(0.5)	5.9(0.7)	8.9(0.8)
10	5.2(0.4)	9.5(0.6)	7.9(1.0)	10.4(1.0)
20	5.9(0.5)	10.8(0.8)	9.5(1.2)	11.8(1.3)
50	6.6(0.6)	12.8(1.0)	11.5(1.5)	13.7(1.6)
100	7.2(0.7)	14.1(1.1)	13.1(1.8)	15.2(1.8)

SPRING

	ANGLE CLASSES 1	2	3	ALL
5	3.6(0.2)	4.9(0.4)	4.3(0.7)	6.3(0.8)
10	4.6(0.3)	6.6(0.6)	5.2(1.0)	7.8(1.0)
20	5.2(0.4)	7.9(0.7)	7.2(1.2)	9.4(1.3)
50	5.9(0.5)	9.2(0.9)	10.5(1.5)	11.7(1.6)
100	6.6(0.5)	10.8(1.0)	12.8(1.8)	13.7(1.8)

SUMMER

	ANGLE CLASSES 1	2	3	ALL
5	2.6(0.1)	3.6(0.2)	3.0(0.3)	3.9(0.3)
10	3.0(0.2)	3.9(0.3)	3.6(0.4)	4.7(0.4)
20	3.3(0.2)	4.6(0.3)	4.6(0.5)	5.4(0.5)
50	3.6(0.2)	5.6(0.4)	5.2(0.6)	6.4(0.6)
100	3.9(0.3)	6.6(0.5)	6.2(0.7)	7.2(0.7)

FALL

	ANGLE CLASSES 1	2	3	ALL
5	3.3(0.2)	4.9(0.7)	6.9(0.3)	7.2(0.8)
10	3.9(0.3)	6.9(1.0)	7.5(0.4)	8.3(1.0)
20	4.6(0.4)	8.2(1.2)	8.2(0.5)	9.4(1.3)
50	5.2(0.5)	9.8(1.5)	9.2(0.6)	10.9(1.6)
100	5.9(0.5)	11.2(1.8)	10.5(0.7)	12.0(1.8)

TABLE A-2 - SIGNIFICANT DEEP WATER WAVE PERIODS AT PORT CLINTON, OHIO

GRID LOCATION 10, 4 LAT=41.69 LON=82.90 PORT CLINTON OH

GRID POINT NUMBER 4

SIGNIFICANT PERIOD BY ANGLE CLASS AND WAVE HEIGHT

WAVE HEIGHT (FT)	ANGLE CLASS 1	2	3
1	2.5	2.5	2.4
2	3.7	3.6	3.4
3	4.8	4.7	4.4
4	5.5	5.4	4.9
5	5.8	5.7	5.3
6	6.1	6.0	5.5
7	6.4	6.3	5.8
8	6.8	6.6	6.0
9	7.1	6.9	6.3
10	7.4	7.2	6.5
11	7.7	7.4	6.7
12	8.0	7.7	7.0
13	8.4	8.0	7.2
14	8.7	8.3	7.5
15	9.0	8.6	7.7
16	9.3	8.9	7.9
17	9.6	9.2	8.2
18	10.0	9.5	8.4
19	10.3	9.8	8.7
20	10.6	10.1	8.9
21	10.9	10.3	9.1
22	11.2	10.6	9.4
23	11.6	10.9	9.6
24	11.9	11.2	9.9
25	12.2	11.5	10.1

$R = 1.26\,H_o' = (1.26)(9.5) = 12.0$ feet

For $H = 3.1$ feet and $\cot\theta = 2.0$; $k = 1.15$ (from Fig 7-13 of SPM)

$R = K(12.0) = 1.15(12.0) = 13.8$ feet

This runup is overestimated due to the fact that Fig 7-8 through 7-12 and 7-14 through 7-18 of SPM are from tests with 1:10 slope whereas the actual beach slope is less in most cases. To remedy this discrepency, we use Goda's charts to calculate the wave heights at the structure for the 1:10 lake bed slope and for the lesser beach slope. The H_{sig}/H_o' for the design slope of 1:100 was computed using the Goda charts.

Goda Correction

1:100 slope

$(H_{sig}/H_o')_{1:100} = 0.25$ (from GODA chart)

1:10 slope

$\frac{d}{H_o'} = \frac{2.8}{9.5} = 0.30$

$\frac{H_o'}{L_o} = \frac{9.5}{(5.12)(7)^2} = 0.04$

$(H_{sig}/H_o')_{1:10} = 0.44$

$$\frac{(H_{sig}/H_o')_{1:100}}{(H_{sig}/H_o')_{1:10}} = \frac{0.25}{0.44} = 0.57$$

Actual Smooth Surface Runup $= (13.8)(.57) = 7.9$ feet

From CETA 79-1, APPENDIX A - Rough Slope Runup Correction Factor for $d_s/H_o' < 3$ and $\cot\theta = 2.0$ is $r = 0.61$

Actual Wave Runup $= (7.9)(.61) = 4.8$ feet
use 5.0 feet

Crest Elevation = water elevation + wave runup height
$= 572.8 + 5.0$

Crest Elevation = 577.8

Typical Sections

Typical Sections for the two areas to be protected at Port Clinton are shown on Plate A-1.

BY RJG DATE 11/12/80 SUBJECT Western Lake Erie Shore - Port Clinton area SHEET NO. 6 OF 6

CHKD. BY [illegible] DATE [illegible] JOB NO.

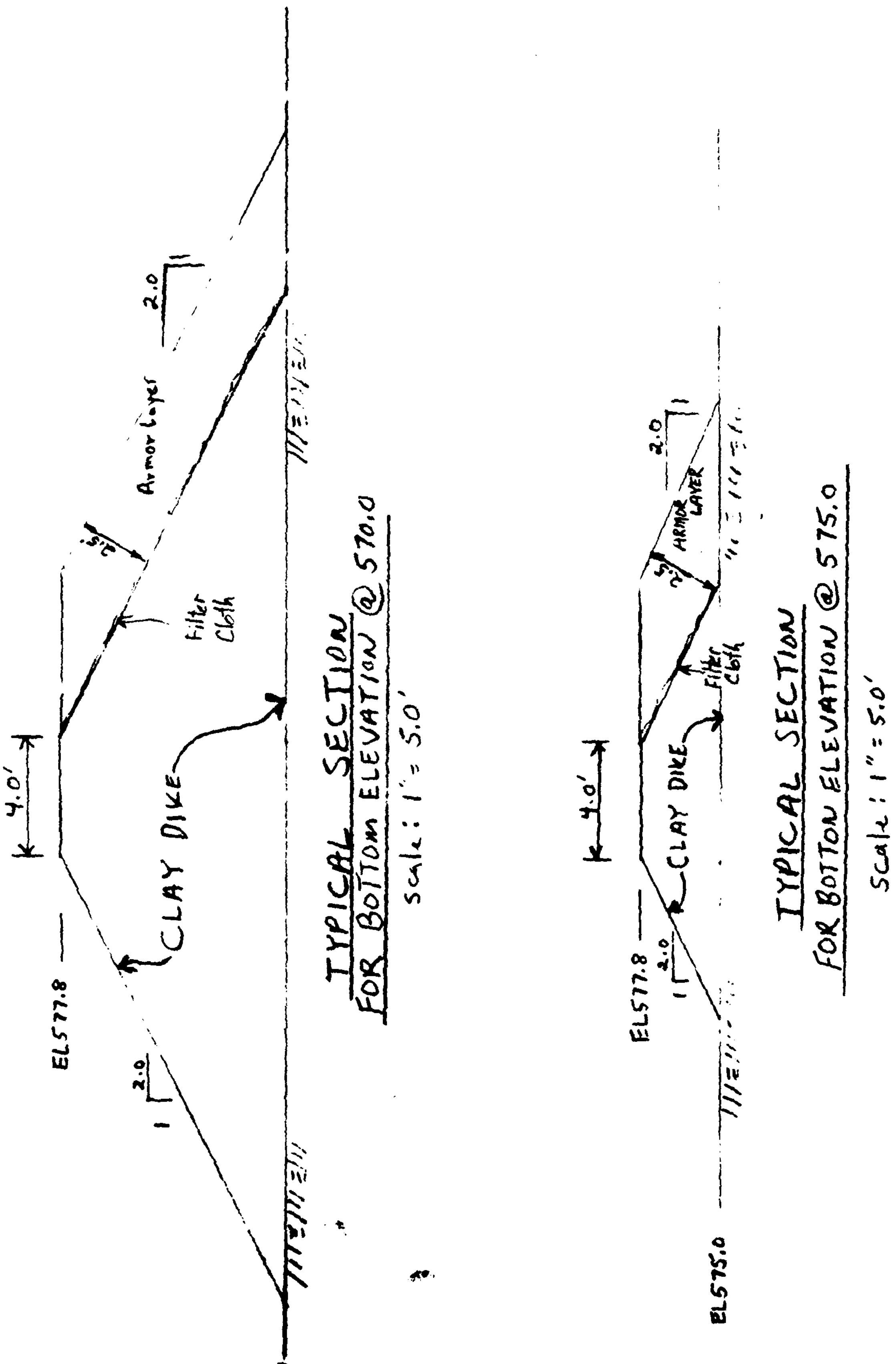


PLATE A-1

APPENDIX D

QUANTITY AND COST ESTIMATES
FOR
PLAN 1
AT

Oregon, Ohio and Port Clinton Ohio

DISPOSITION FORM

For use of this form, see AR 340-15, the proponent agency is TAGCEN.

REFERENCE OR OFFICE SYMBOL	SUBJECT
NCBED PW	COST ESTIMATES CLAY DIKES WEST, LAKE ERIE SHORE - RECON, REPORT

TO	FROM	DATE	CMT 1
R. NICAISE	R. MAMMOSER	~~DEC. 80~~ JAN. 26, 81	

THRU: CHIEF, W.C. 931/86
CHIEF, PLANNING for 83.1/86
CHIEF, DESIGN

1. ATTACHED IS INFORMATION ON SUBJECT STUDY AS FOLLOWS:
   a.) PLAN OF OREGON, PORT CLINTON, OHIO
   b.) TYPICAL DIKE SECTIONS
   c.) MATERIAL SOURCE, CLAY FILL
   d.) DF from design - source of clay fill
   e) Wave Analysis

2. REQUEST THAT YOU PROVIDE COSTS FOR EACH OF THE THREE STRUCTURES. AVG. ANNUAL DAMAGE IS $27,000 FOR OREGON AND $150,000 FOR PORT CLINTON, OHIO.

3. APPROXIMATE LENGTH AND LOCATION OF PARTICULAR SECTIONS IS SHOWN ON ATTACHED PLANS. BECAUSE OF LIMIT OF DAMAGES ONLY A "ROUGH" ESTIMATE IS REQUIRED. No details required on "tie in" at this time.

4. CHARGE: AB-N01-01-110-0-0000.

R. Mammoser

DA FORM 1 FEB 62 2496 REPLACES DD FORM 96, WHICH IS OBSOLETE. ☆GPO-1975-665-422/1063

[redacted]

SHEET 2 OF 7

PROJECT: WEST LAKE ERIE SHORE RECON REPORT.

INVITATION NO.

ITEM NO.	DESCRIPTION	ESTIMATED QUANTITY	UNIT	UNIT PRICE	ESTIMATED AMOUNT
	OREGON - CLAY DIKE 11,000 LF				
	COMPACTED EMBANKMENT (CLAY DIKE)	90,800	C.Y.	$ 17.00	1,543,600
	ARMOR LAYER	36,800	TON	$ 43.00	1,582,400
	FILTER CLOTH	35,500	S.Y.	$ 3.50	124,250
	CARE of WATER	11,000	L.F	$ 25.00	275,000
	SUBTOTAL				3,525,250
	CONTINGENCIES @ 25%				884,750
	CONTRACTOR'S EARNINGS PLUS CONTINGENCIES				4,410,000
	Port CLINTON CLAY DIKE 12,000 LF				
	COMPACTED EMBANKMENT	68,000	C.Y	17.00	1,156,000
	ARMOR LAYER	27,200	TON	43.00	1,169,600
	Filter Cloth	30,800	S.Y.	3.50	107,800
	CARE of Water.	12,000	L.F	25.00	300,000
	SUBTOTAL				2,733,400
	CONTINGENCIES @ 25% ±				686,600
	CONTRACTOR'S EARNINGS plus Conting.				3,420,000
	Port Clinton CLAY DIKE 10,000 LF				
	COMPACTED EMBANKMENT (CLAY DIKE)	10,000	C.Y.	17.00	170,000
	ARMOR STONE	8100	TON	43.00	348,300
	Filter Cloth	1350	S.Y	3.50	4,725
	SUBTOTAL				523,025
	CONTINGENCIES @ 25%				126,975
	CONTRACTOR'S EARNINGS plus Conting				650,000
	Total FIRST Cost for OREGON & PORT CLINTON				$ 8,480,000

ENG FORM APR 67 1738 SUPERSEDES ENG FORM 1738, 1 APR 64, WHICH IS OBSOLETE.

Subject West LAKE ERIE SHORE - RECON. REPORT
Computation of QUANTITIES
Computed by L.R.K. Checked by Date 28 JAN. 1981

OREGON

CLAY DIKE (in water) $[2(9.6^2) + 4(9.6)] \times 11{,}000/27 = 90{,}738$ CY
USE 90,800 CY

ARMOR LAYER, 362# & 50T# $(6.71 \times 9.6) \times 11{,}000/27 = 26{,}2??$ CY $\times 1.4$
OR 36,800 TON

Filter Cloth $29^{LF} \times 11{,}000 = 319000^{SF} \div 9 = 35{,}444^{SY}$
USE 35,500 SY

Port Clinton

CLAY DIKE (in water) $[2(7.8^2) + 4(7.8)] \times 12{,}000/27 = 67{,}947$ CY
USE 68,000 CY

Armor Layer. $5.6 \times 7.8 \times 12{,}000/27 = 19{,}414$ CY $\times 1.4$
27,188 TON
USE 27,200 TON

Filter Cloth. $(17.5 + 5.6) \times 12{,}000/9 = 30{,}800$ SY

Port Clinton shore DIKE

CLAY DIKE $[2(2.8^2) + 4(2.8)] \times 10{,}000/27 = 9{,}956$ CY USE 10,000 CY

Armor Stone. $5.6 \times 2.8 \times 10{,}000/27 = 5{,}807$ CY $\times 1.4 = 8131$ TON
USE 8,100 TON

FILTER Cloth $12^{LF} \times 10{,}000/9 = 1{,}333$ SY
USE 1,350 SF

Subject WEST LAKE ERIE Shore Recon Report.
Computation of DETERMINATION of Costs.
Computed by L.R.K. Checked by ______ Date ______

CLAY DIKE Compacted Embankment (including Borrow & Hauling 75 mi)

ABSTRACTED FROM ERIE DIKE Disposal Clay Type X

AVG of THREE BIDS = $\frac{\$[illegible]}{3}$ = \$4,700/350 CY = \$13.43/CY in place.

Escalation to JAN 1, 1981 Price Level = 13.43 × $\frac{3372}{2687}$ = 16.91/CY Use 17.00

ARMOR LAYER 360# to 807#

PRICE ABSTRACTED FROM CHANNEL PROTECTION GENESEE RIVER @ Houghton N.Y.

AVG of THREE BIDS = $\frac{\$181}{5}$ = 36.20/TON

Price ESCALATED to JAN 1, 1981 = 36.20/TON × $\frac{3372}{2829}$ = 43.15/TON Use 43.00

Filter Cloth.

PRICE ABSTRACTED FROM CHANNEL Protection Genesee River AT Houghton N.Y.

AVG. THREE BIDS = $\frac{14.50}{5}$ = \$2.90

Price Escalation to 1, JAN 1981 = \$2.90 × $\frac{3372}{2829}$ = 3.46 Use \$3.50 Use 3.50

CARE of Water.

ABSTRACTED FROM Freemont Flood Control Project. L.S. 225,000

USED to Construct 18,300 LF of Levee and 3,500 LF Flood Wall:

∴ $\frac{\$225000}{21,800}$ = \$10.32/LF

Price ESCALATED to 1-Jan-81 = 10.32 × $\frac{3372}{1377}$ = 25.30 Use 25.00/LF

OREGON

FIRST COST CONSTRUCTION		4,410,000
E&D	.15	661 500
S&A		
S&I	.06	264.600
OH[ED]	= .19	125,700
OH [S&I]	= .32	84,700
TOTAL		5,546,500
SAY		$ 5,550,000

PORT CLINTON

FIRST COST		
IN WATER		3,420,000
ON LAND		650,000
TOTAL FIRST COST		$ 4,070,000
ED	.15	610 500
S&A		
S&I	.06	244 200
OH [ED]	.19	116,000
OH [S&I]	.32	78 200
TOTAL		5,118,900
SAY		$ 5,120,000

16.5
18.5
35.0
17.5

LEVEES:

ED – 11% – 16.5% 27 1/2 = 13 3/4

S&I – 5 1/2% – 7 1/2% 6.5

13.75
16.5
30.25
15.125

FLOOD WALLS/INTERIOR DRAINAGE

ED – 14 1/2 – 18 1/2 % 33 = 16 1/2

S&I – 6 1/2 – 8 1/2 % 7.5

	8,480,000
15%	1,272,000
17.5	1,484,000

%			
	8,480,000		8,480,000
15.0 ED	1,272,000	17.5	1,484,000
S&A			
6 S&I	508,800	8	678,400
19 OHED	241,700	19	282,000
32 OHSI	162,800	32	217,100
	$10,665,300		11,141,500

DISPOSITION FORM

For use of this form, see AR 340-15, the proponent agency is TAGCEN.

REFERENCE OR OFFICE SYMBOL	SUBJECT
NCBED-DG	WEST, LAKE ERIE SHORE - RECON REPORT COST ESTIMATES

TO R. MAMMOSER, PLANG. BR. FROM Chief Genl Engr Sec. DATE 3 Feb 1981 CMT 1

THRU Chief Design Br
Chief Plang. Br
Chief Western Basin, Plang. Br.

1. Reference your DF dated 26 JAN 81 Subject as above.

2. There is attached here to subject cost estimate

3. Please note the is no provision in the estimate for any internal drainage work. You should determine if any is required and react accordingly.

R. J. [illegible]

P.S. Material furnished with referenced DF has been retained in Genr. Engr. Sec.

WESTERN SHORE OF LAKE ERIE, OHIO

BEACH EROSION CONTROL

AND

FLOOD DAMAGE PREVENTION STUDY

A Preliminary Fish and Wildlife Coordination Act Report

Submitted to:

Buffalo District
U. S. Army, Corps of Engineers
Buffalo, New York

November
1979

Prepared by:

Columbus Field Office
Division of Ecological Services
U. S. Fish and Wildlife Service
Columbus, Ohio

Released from:

East Lansing Area Office
U. S. Fish and Wildlife Service
East Lansing, Michigan

APPENDIX E

U. S. FISH AND WILDLIFE SERVICE

PRELIMINARY F&WL COORDINATION REPORT

November 1979

TABLE OF CONTENTS

PROJECT DESCRIPTION

Shore erosion and flooding are major water resource problems on the Great Lakes. The principal causes of shore erosion and flooding problems in the Great Lakes area are the forces of nature and the characteristics of the shoreline area subjected to these forces. Predominant among the forces affecting the study area are the water levels of Lake Erie and winds. In recent years, the western Lake Erie shoreline has experienced high water levels which when combined with strong north to northeasterly winds cause rapid beach and bluff erosion and flooding of low lying areas along the shoreline.

The Army Corps of Engineers was authorized on April 11, 1974, by House resolution to conduct a beach erosion control and flood damage prevention study. The purpose of the study is to investigate shore erosion and flooding problems caused by high Lake Erie water levels and winds along the western shore of Lake Erie and western basin islands. It is the intention of this preliminary Fish and Wildlife Coordination Act report to present a description of the fish and wildlife resources within the study area and provide information and recommendations to aid the Corps of Engineers in developing environmentally sound solutions to these problems.

STUDY AREA

The study area includes the southwestern Lake Erie shoreline. This area is also referred to occasionally as the "western Lake Erie shore." While the "western" or "southwestern" Lake Erie shore generally refers to the shoreline extending eastward from the Ohio-Michigan state boundary to Sandusky, Ohio, including the shoreline along Sandusky Bay, the present study only includes approximately 55 miles of shoreline from the Ohio-Michigan state boundary to Marblehead, Ohio. However, the study area also includes approximately 41.5 miles of shorelines of the Lake Erie western basin islands and shorelines and flood prone areas along waterways entering Lake Erie which experience a "lake effect", such as the Maumee and Portage Rivers. Figure 1 presents a map of the study area.

Brief History

Prior to 1795, when all of northwestern Ohio was Indian territory, there existed an extensive swamp and marsh known to settlers as the "Great Black Swamp". The Black Swamp occupied an area 30 to 50 miles wide and 120 miles long extending across northwestern Ohio from the Port Clinton area westward up the Maumee River drainage to Indiana (Langlois, 1954).

Construction of canals, levees, and drainage ditches in the 1800's began the transformation of the Black Swamp to fertile agricultural land, and rapid settlement and agricultural development soon followed. By the late 1800's, the

pattern of drainage in northwestern Ohio as it exists today was established, and the extensive wetlands were reduced to a narrow band along the southwest border of Lake Erie.

Cultivation of drained marshlands was not without some risks. Crops were sometimes flooded from high lake levels, seiches, wind generated wave action, and unusually heavy precipitation. Thus, some farmlands were abandoned and rapidly reverted to marsh. Hunting, fishing, and trapping in marshes became an alternative land use for these flood-prone areas and provided some means of compensation to farmers for crop losses. By the 1900's, the motivation behind dike and levee construction began to include marsh management for waterfowl and muskrat production as well as flood protection of agricultural lands.

DESCRIPTION OF THE RESOURCES

Physical, Chemical, and Geographical Environment

Numerous publications exist which describe the physical, chemical, and geographical parameters of Lake Erie. Various biological theses of students from Ohio State University give brief descriptions of the geological history and limnology of Lake Erie and the western basin. More detailed descriptions of Lake Erie limnology is offered by Beeton (1963), the U.S. Federal Water Pollution Control Administration (1968) and the Great Lakes Basin Commission (1976). Information on Maumee Bay and the Maumee River has been compiled as a result of dredging and pollution studies. Herdendorf and Cooper (1975) and Pinsak and Meyer (1976) provide two of the more recent reports on Maumee Bay and River limnology.

Critical erosion areas along the Lake Erie shore have been identified by Langlois (1954), the Army Corps of Engineers (1971), and the Great Lakes Basin Commission (1975). Recession rates have been studied and recorded since 1876 by Ohio's Division of Geological Survey. The effects of structures upon the shoreline have been discussed in reports by Hartley (1964) and Carter (1973). Generally, critical erosion areas appear to be located in areas of low glacial till and lacustrine clay bluffs and plains.

Topography

Most of the shoreline within the study area is composed of varying segments of low bluffs, low plains, barrier beaches, artifical shorelines, and wetlands. Benson (1978) mapped the distribution of these major shore types along the Lucas County-Lake Erie shore. In its natural state much of the shoreline was marsh fronted by low barrier beaches. While the shorelines of Catawba peninsula and the islands are rugged in nature, the remaining shoreline became modified by the addition of riprap and dikes in an attempt to protect the shore from destructive wave action and to

maintain wetlands. Barrier beaches presently range from less than 10 feet to 80 feet in width. The lack of significant beach accumulations in recent years is thought to be the result of prevailing littoral systems, the scarcity of beach-building materials in the Lake Erie ecosystem, and the trapping of sand and its removal from the littoral system by shore protection structures and shoreline development.

Shoreline elevations around Maumee Bay seldom exceed four feet above mean lake level. Elevations increase gradually eastward until Catawba Island and Marblehead where the resistant limestone bedrock creates 30 to 70-foot high bluffs and cliffs. The four miles of shore from West Harbor to Lakeside is low and bordered by sand beaches. Shores of all the major islands are rugged in character with bluffs along the major portions of the island perimeters. The highest elevations are normally adjacent to the west shores, except West Sister Island where the bluffs are highest along the east shore.

The study area includes the western basin of Lake Erie which can roughly be described as that portion of Lake Erie west of a north-south line extending from Point Pelee, Ontario to Sandusky, Ohio. The physical characteristics of the western basin differ considerably from the remainder of Lake Erie. Separated from the deeper central part of Lake Erie by a belt of resistant bedrock and reefs, the western basin comprises 13% (1500 $\pm$ 300 square miles, depending upon the lake level) of the total lake area but due to its shallowness contains only 5% (5.8 cu. miles) of the total lake volume. The western basin contains many shoals, reefs, and islands and is relatively shallow, with an average depth of approximately 24 feet.

The study area also includes portions of the northern Ohio lake plain. The lake plain, similar to the western basin, is characterized by low relief. The flat topography of northern Ohio varies less than 100 feet above lake level. Unless exposed, as along Catawba Island, the bedrock is covered with glacial till and lacustrine clay left by the retreating glacier. Shallow streams and rivers dissect an otherwise relatively undifferentiated lake plain. The major streams and rivers within the project area are the Ottawa River, Maumee River, Turtle Creek, Toussaint River, Lacarpe Creek, and Portage River.

The low relief and subsequent poorly drained areas of northern Ohio contributed to the creation of an extensive wetland along the lake and bay shoreline. Barrier beaches were believed to have separated a significant portion of the wetlands from the main part of the lake and functioned to control some of the influx and outflow of water from the lake. While the actual size of this wetland varied with lake levels, seiches, and storm action, as much as 300,000 acres was believed to have originally existed along the Lake Erie shore and northwestern Ohio.

<u>Major Habitat Types and Vegetation</u>

The wetlands constitute a major habitat type of the Lake Erie area. These areas of high productivity support a myriad of biological communities and serve as concentration areas for various fish and wildlife species. Data compiled by Stuckey

and Roberts (1977) indicate that the aquatic habitats in nor'heastern Ohio and the marshes along the shoreline of Lake Erie in northwestern Ohio have the greatest diversity of aquatic vascular plants in the state. Today, the Lake Erie wetlands along the Ohio shoreline form a discontinuous band. The dynamic character of wetlands makes it nearly impossible to accurately calculate wetland acreages at any given time. Current estimates for wetlands existing in Ohio vary greatly according to the time of year an inventory was made, management practices, lake levels, and degree of disturbance to wetlands by man, winds, storms, seiches, or other factors. An Ohio Coastal Zone Management study estimated that over one-half of the wetlands that existed in Ohio in 1955 have been lost. The Ohio CZM staff has estimated that approximately 15,000 acres of coastal wetlands remain in Ohio. In a 1979 in-house Fish and Wildlife Service report on waterfowl in Ohio by Jon Kauffeld, a reference is made that approximately 14,000 acres of wetlands exist along the western Lake Erie shoreline. Less than 10,000 acres of wetlands are estimated to exist within the project area. Figure 2 illustrates the location of significant wetlands of the southwestern Lake Erie-northwestern Ohio area. Tables 1 and 2 list wetlands of the southwestern Lake Erie area.

Of the few remaining marshes open to Lake Erie in the project area, Metzger Marsh State Wildlife Area is the largest. A small area, planned as part of Maumee Bay State Park and located immediately west of Cedar Point NWR, is presently an unmanaged open marsh. Other small areas of open marsh may exist in the floodplains of the streams and rivers in the area. The short-term productivity of these unmanaged marshes has been reduced over the last few years by the recent high lake levels, however, periodic inundation may be necessary to maintain the long-term productivity of marshes.

Many of the Lake Erie marshes are managed for waterfowl. Large areas of marshland have been diked off from the main waters of the Lake, bay, and rivers. Through water control operations, water within the dikes may be maintained at any desired level according to waterfowl needs.

In one management scheme, flooding and drawdown practices alter normal plant succession to encourage the germination and growth of desirable forms of vegetation and exclude others according to migrating waterfowl needs. Marshes are drained in mid-to late May to favor the germination of smartweeds, Walter's millet, and rice-cutgrass. Subsequent reflooding in September then makes these dense stands of vegetation available to migrating waterfowl. This practice is commonly used at Magee Marsh State Wildlife Area, the Ottawa National Wildlife Refuge Complex, Winous Point Shooting Club, and Toussaint Creek State Wildlife Area.

Another management scheme in common use by private marsh owners and private shooting clubs is aimed toward the harvest of waterfowl. This management scheme involves the draining of diked marsh areas and then planting the area to corn or soybeans. After the crops are harvested in late August and September, the area is flooded allowing migrating waterfowl to feed on the crop residue.

A list of the common aquatic plants of the Lake Erie marshes is presented in Table 3. In Table 4, information on aquatic plant water regimes is provided. The water regime categories are adapted from Cowardin et al. (1977), Classification of Wetlands and Deep-water Habitats of the United States. The water regimes used in Table 4 are as follows:

> Permanently Flooded - Water covers the land surface at all times of the year in all years. Vegetation is composed of obligate hydrophytes.
> Intermittently Exposed - Surface water is present throughout the year except in years of extreme drought.
> Semipermanently Flooded - Surface water persists throughout the growing seasons in most years. When surface water is absent, the water table is usually at, or very near, the land surface except during severe drought.
> Seasonally Flooded - Surface water is present for extended periods early in the growing season, but is absent by the end of the season in most years. When surface water is absent, the water table is usually near the land surface.
> Saturated - The substrate is saturated to the surface for extended periods during the growing season, but surface water is seldom present.
> Temporarily Flooded - Surface water is present for brief periods during the growing season, but the water table usually lies well below the soil surface for most of the season. Plants that grow both in uplands and wetlands are characteristic of the temporarily flooded regime.
> Intermittently Flooded - The substrate is usually exposed, but surface water is present for variable periods without detectable seasonal periodicity. Weeks, months, or even years may intervene between periods of inundation. The dominant plant communities under this regime may change as soil moisture conditions change. Some areas exhibiting this regime do not fall within the definition of wetland because they do not have hydric soils or support hydrophytes.
> Drawdown - The amount and duration of flooding is under the direct and purposeful control of man; it does not depend on normal variation in precipitation or river flow.

In addition to wetlands, other natural habitats found along the southwestern Lake Erie shoreline include sandbars, beaches, mudflats, fields, forests, and secondary growth areas. The sandbars, beaches, and mudflats in the study area are limited. The transport of sand has been impeded by the development of various shore structures. Shore structures trap the limited quantity of available sand in the littoral drift system and prevent sand accumulations in the downdrift areas. Shore protection efforts by land owners have further limited the development, accessibility, and availability of mudflats and beaches. Vegetation in these areas varies depending on the vegetation in immediate upland areas and may include any of the aquatics listed in Table 3 and pioneer or soil stabilizing species.

Fields abutting the shorelines in the project area may be cultivated or uncultivated and may be vegetated by hay, clover, alfalfa, corn, soybeans, and winter wheat. Grasses may include Kentucky 31, tall fescue, rye grass, timothy grass, red fescue,

and other introduced species. Old, uncultivated fields commonly support a wide variety of grasses and broad leaved herb species including Canadian thistle, goldenrods, asters, wild carrot, teasel, yellow sweet clover, and mustard species.

Mature forest habitats in the project area are limited. Dominant tree species include those which are common in bottomland and floodplain areas, such as white ash, elm, red maple, cottonwood, sycamore, birch, boxelder, and hackberry. These hardwoods are more tolerant of moist soil and swamp conditions. On well-drained land, oak-hickory associations including red oak, bur oak, white oak, shagbark hickory, black walnut, tuliptree and ash may be prevalent.

Secondary growth areas are those areas which are typified by shrubs and brush thickets composed of honey locust, red-osier dogwood, sumac, wild plum, crabapple, hawthorn, choke cherry, witch hazel, hazelnut, blackberry, and wild grape. These seondary growth areas are common along forest edges, canals, and ditches.

Other descriptions and lists of vegetation occurring along southwestern Lake Erie may be found in Core (1948), Bartolotta (1979), Lowden (1969), and Pieters (1902). Cooper and Herdendorf (1977) presented several tables taken from Stuckey and Duncan (1977) which listed vegetation according to their ecological association. Tables on rare and distinctive plants of Kelleys Island quarries are presented in Cooper and Herdendorf's report. While these tables have been developed for the Lake Erie Islands, many of these plants would be found in similar associations along the Lake Erie coast. Tables 5, 6, 7, 8, 9, and 10 have been reproduced from the Cooper and Herdendorf (1977) report.

Presently, one plant species, pinkweed (*Polygonum pensylvanicum L.* var. *eglandulosum*) is proposed as a federally endangered plant. Pinkweed, or Pennsylvania smartweed has been found in Ottawa County and is associated with damp and disturbed areas. The State of Ohio has proposed a list of threatened and endangered plant species; however, this list has not reached any official status to date. The Ohio Natural Heritage Program has indicated that numerous species located in Lucas and Ottawa Counties have been placed on the proposed Ohio list. A publication on rare and endangered aquatic vascular plants of Ohio has been written by Stuckey and Roberts (1977). The publication indicates that 33 aquatic plant species in Lucas County and 31 aquatic plant species in Ottawa County are considered either extirpated, endangered or threatened.

Zoobenthos, Zooplankton and Phytoplankton

Zoobenthos

The drastic environmental changes in Lake Erie have greatly changed the composition of the benthic fauna of western Lake Erie (Britt et al., 1973). Changes in the benthic community can be attributed to: 1) siltation from erosion and

dredging, 2) industrial and municipal wastes, 3) intensive agricultural practices, 4) stream and river rehabilitation projects, 5) misuse of persistant chemicals (DDT, TFM, PVC, PCB), 6) exploratory drilling for petroleum distillates, and 7) waste materials from mining operations. Low dissolved oxygen concentrations in 1953 virtually eliminated the Hexagenia-Oecetis (mayfly-caddis fly) community (Britt, 1956). The deepwater bottom fauna has since been dominated by oligochaetes and midges. The aquatic diptera population has changed such that present conditions favor the pollution tolerant Tanypodinae over the Chironomidae. Invertebrates recorded as being present in Lake Erie are listed in Table 11.

Early studies of Lake Erie benthos found a diverse community. (Krecker and Lancaster, 1933; Shelford and Boesel, 1942; and Wright, 1955) During the 1930's, the significant taxa were Ephemeroptera (mayflies).

The species composition of the benthic community began to change in the 1950's. The formerly abundant mayflies were reduced to less than one percent of their former abundance by the 1960's. From 1929 to 1965, Oligochaeta (freshwater earthworms), Chironomidae (midges), Gastropoda (snails) and Sphaeriidae (fingernail clams) showed increases by factors of nine, four, six and two, respectively. The most common groups of benthic animals in the western basin are, in decreasing order: oligochaetes, midges, molluscs, nematodes, leeches, crustaceans, mayflies and caddis flies (Britt et al., 1973). Many studies describe Lake Erie bottom fauna: Ohio Division of Water (1953); Wood (1963); Hiltunen (1969); Beeton and Chandler (1963); Wolfert and Hiltunen (1968); International Joint Commission (1969); Beeton (1970); Herdendorf et al. (1976); Hartley (1975); and Pliodzinskas (1978).

Table 12 shows the abundance and distribution of benthos according to depth, type of substratum, and vegetation. The literature generally agrees as to whether a species is littoral, sublittoral or profundal, but precise depth ranges often vary widely. So many factors such as temperature, light intensity, dissolved oxygen, wave action and the availability of food are related to depth that published depth ranges should be regarded as tentative (Great Lakes Basin Commission, 1976). Shallow nearshore waters seem to be most favorable for benthos perhaps because of the high food production, which is dependent on light penetration, or because of inflow of allochthonous material from the watershed. Tubificids are found at all depths, but are least abundant above 3 m and below 66 m.

It is widely recognized that rocky and sandy substrata support relatively few benthic organisms compared to mud bottoms. Bottom type should not, however, be the only factor considered when determining benthic distribution. For example, Pontopereia is not ascribed to rocky bottoms, but is able to flourish on a bedrock substrate if it is covered with epilithic algae (Adams and Kregear, 1969). Sand bottoms are usually unstable and unsuitable for many benthic species (Veal and Osmond, 1968). Krecker and Lancaster (1933) related western basin benthos

distribution to the complex series of bottom types found in that basin. However, organic content seems to be a more important factor than sediment texture in determining distribution and abundance of benthic species.

High flow rates and wave action are limiting factors for most species, both planktonic and benthic. Wave action is particularly important in the distribution of snail species in western Lake Erie. Some species are inhibited by wave action if the substrate lacks large rocks; others can tolerate essentially no wave action and require vegetation, while others need both vegetation and wave action. Mussels are completely lacking on certain wave swept shoals in Lake Erie even though the bottom type is suitable. In protected habitats, mussels grow larger than in unprotected habitats (Brown et al., 1938). Rotifer blooms occur during times of the year when there is little turbulence (Williams 1966).

Most species of Great Lakes fish feed heavily on the zooplankton and zoobenthos. Even the mainly piscivorous species rely on these organisms when they are fry. The Copepoda, Cladocera, Hydracarina, Ostracoda, Mysis, Amphipoda, crayfish, Chironomids and various larval insects, most notably Trichoptera and Ephemeroptera, are important fish food. Oligochaetes, leeches and molluscs are not as important as fish food items.

Zooplankton

The total zooplankton biomass has increased drastically from the 1930's (Wright and Tidd, 1933; Chandler, 1940; Davis, 1968; Beeton, 1970; Hartman, 1973; Patalas, 1971; Britt et al., 1973; Reutter and Reutter, 1975; Rolan et al., 1973; Canada Center for Inland Waters, 1972; Watson, 1976; Herdendorf et al., 1975, 1976; Hartley, 1975).

The present zooplankton community is similar to the earlier community, but with these changes: 1) Limnocalanus macurus, a copepod, has become established, 3) Diaptomus siciloides, a euryhaline copepod, is increasing, 4) Bosmina coregonii, a cladoceran, has increased. An increase in the crustacean zooplankton, dominated by copepods and cladocerans has occurred in western Lake Erie. Daphnia sp. dominate in late spring and Boxmina sp. in late August. The number of copepods increased from 70,000 per cubic meter in 1939 to 126,000 in 1967. These changes are indications of eutrophic changes in the zooplankton community.

Phytoplankton

The changes in the phytoplankton of western Lake Erie since 1929 have been described in many studies; Wright (1955); Chandler and Weeks (1945); Ohio Division of Water (1953); Verduin (1951,1954); Davis (1962, 1964, 1968); Hohn (1969),

Anderson (1969), International Joint Commission (1969), Reitz (1973); Britt et al. (1973); Herdendorf et al. (1975, 1976); Hartley (1975) and Munawar and Munawar (1976). Changes in phytoplankton have not been as dramatic as in the benthic fauna.

Microcystis has replaced Aphanizomenon and Oscillatoria as major constituents of the blue-green algae. Filamentous algae, not previously reported in significant quantities, now appear in large numbers. A striking increase in the number of dinoflagellates, Ceratium hirundinella and Peridinium, which occurred only rarely in the past, has resulted in their becoming a major component of the plankton community (Britt et al., 1973). Beeton (1970) summarized phytoplankton changes from 1929 to 1963 as follows: 1) a three-fold increase in phytoplankton biomass (especially blue-green and green algae), 2) spring and fall maxima have increased in length and impact, and the minima have become shorter and less pronounced, 3) Melosira binderana, an algae of eutrophic waters, comprised up to 90 percent of the plankton at times, replacing Asterionella as the dominant spring diatom. Fall dominance has shifted from Synedra to Melosira to Fragillaria. Blue-green algae blooms appear in late July to early August as floating mats on the water.

For more complete information on the plankton of the nearshore zone of Lake Erie, readers are referred to a study by D. A. Culver (1977), which emphasizes plankton and bacteria as indicators of water quality.

Conclusions

Changes in the species composition and the population density of the various plants and animals in Lake Erie have occurred at a tremendously accelerated rate. Although the mechanisms of these changes are not documented and qualitative information on the ecology of zooplankton and phytoplankton is lacking, cultural pollution and eutrophication are generally named as the causes of these changes.

Areas with the greatest tendency to become anaerobic are inshore waters near cities and the bottom portion of the open water. The central basin has a more critical oxygen depletion problem than the western basin due to its tendency to stratify. Low dissolved oxygen levels in the western basin were first reported in 1930 (0.78 ppm) (Wright et al., 1955). Britt (1955) reported the severe oxygen depletion in 1953 and subsequent mayfly population decline. Oxygen depletion in the central basin now becomes so severe in summer months that large areas become anoxic and in the western basin depressed dissolved oxygen concentrations are not uncommon. Oxidation of the large organic load in Lake Erie during periods of low circulation causes the low oxygen conditions so unfavorable for the obligate aerobic benthic fauna. Changes in phytoplankton populations have been related more to the changes in micronutrient or organic compounds as a result of pollution (Britt et al., 1973). Since these materials are continually recycled in the shallow waters of the western basin, it is unlikely that pollution control would show an immediate effect.

The delicate ecosystem of a lake bed is readily destroyed by smothering with even a thin covering of sand, clay, or silt. Silt can coat submerged aquatic plants and prevent photosynthesis. The once diverse aquatic vegetation in Lake Erie sheltered many organisms and tended to aid in clarifying waters and in preventing excessive phytoplankton blooms, which occur commonly today (Trautman, 1977).

The lake bed provides breeding and nesting areas and shelter for many species of plants and animals. The effects of its degredation are evident throughout the entire food web.

Fisheries of the Nearshore Zone of Southwestern Lake Erie

Utilization and alteration of the Lake Erie shoreline continue to increase with obvious impact upon water quality, substrate and resident animal life in the nearshore waters. Information on nearshore fish communities and their seasonal habitat associations is generally lacking, but is needed to provide criteria for future shoreline development least destructive to the fish communities. Currently, the Ohio Department of Natural Resources, Division of Wildlife, is conducting a study of Ohio's Lake Erie shoreline fish communities. The objective is to determine the distribution and relative abundance of juvenile and adult major sport fish and their seasonal associations with each of the major shoreline habitats (Ohio Division of Wildlife, 1979). A study of this magnitude requires a major effort involving prolonged and intensive surveying techniques such as electrofishing, gill netting and seine sampling during all seasons and at all hours. This study should provide the kind of data essential for improved planning of coastal projects so that fish communities need not decline nor their relationships to one another change because of habitat loss.

This section provides a review of available literature pertaining to the fisheries of the nearshore area in western Lake Erie from Maumee Bay eastward to the Bass Islands region. Fish are distributed along the shore according to depth, bottom type, cover availability, temperature, and water quality. Since the western basin is not uniform in these characteristics, the dimensions of the nearshore zone, relative to fish, are not precise. For purposes of this report, the nearshore zone includes the shallows near the shore, offshore reefs and shoals, and the estuarine lower courses of the tributaries within the boundaries already described.

Changes in the Lake Erie Fishery

For the past 200 years, the activities of the continually increasing human population surrounding Lake Erie have radically changed the fish communities and their habitats. Intensive and selective commercial fishing, watershed and shore erosion, nutrient loading, invasion of new species via canals, stream destruction and wetland drainage are some of the stresses that have been imposed upon Lake Erie

(Arnold, 1969; Lewis, 1969; Hartman, 1973; Regier and Hartman, 1973). Since the beginning of this century, basic lake fertility has increased, striking changes have occurred in the density and species composition of phytoplankton, summer oxygen deficits have progressively increased, and the benthos of the western basin has completely changed (Beeton, 1961, 1969; Carr and Hiltunen, 1963; Verduin, 1964, 1969; Britt et al., 1973). Deep, oxygenated coldwater areas, vegetated areas, clean bottom sand and gravel areas, estuaries and wetlands have been considerably reduced in size since 1850.

The loss and degradation of these habitats used for spawning, nursing, feeding, migration, overwintering, resting, and refuge have reduced the diversity of the Lake Erie fishery (Doan, 1942; Van Oosten, 1948; White et al., 1975; Leach and Nepzy, 1976). Many valuable commercial fish species such as lake trout, lake herring (cisco), lake whitefish, sturgeon, blue pike, sauger, and walleye have fluctuated and declined while other less valuable (less marketable) species such as carp, goldfish, and gizzard shad have appeared and proliferated (Table 13). The current estimated species ranking in terms of biomass for Ohio waters of Lake Erie is headed by shiners and gizzard shad, neither of which are harvested commercially (Table 14).

Although Lake Erie is the smallest of the Great Lakes, the annual commercial harvest is about 50 million pounds, nearly 40 percent of all the Great Lakes commercial harvest. This high productivity has been attributed to Lake Erie's shallow, fertile, warmer waters (Applegate and Van Meter, 1970). Lake Erie biological production is at an all time high, but fish production has been directed to species considered "second rank" before 1900, when commercial production of salmonids was still high (Pinsak and Meyer, 1976).

Van Meter and Trautman (1970) list 138 species of fish representing 24 families and 55 genera as having been present in Lake Erie and its tributaries. 43 of these species are limited to tributaries and inland lakes, ponds, and wetlands and 95 are lake species. About one-fifth of the lake species were either introduced and did not become established or were native species which have become extirpated from Lake Erie. Over one-third of the rest of the lake species are considered rare (Hartley and Van Vooren, 1977). Allison and Hothem (1975) define a "rare" species as one recorded only once or very infrequently, and invariably in small numbers.

This leaves less than 50 species which with intensive sampling can be currently found in Lake Erie. These 50 species are considered at least "uncommon" by Hartley and Van Vooren (1977). Allison and Hothem (1975) define "uncommon" relative abundance as a regular occurrence of a species in collections, but usually in small numbers.

Table 15 lists 82 historic and current species found in the nearshore zone, their relative abundance in Lake Erie, and their relative utilization of the nearshore zone. These 82 species make (or made) some use of the nearshore zone at some time during their life cycles.

Data Presentation

A discussion of the major Lake Erie fish species follows. Fish included in this review are considered "major" species due to 1) their value as commercial or sport fish, 2) their numbers, or 3) their value as food for important game fish.

A general discussion of other western Lake Erie fish species and a review of nearshore fish communities follows the discussion on major species, with a final section providing recommendations to minimize project-caused adverse impacts on fisheries habitat.

Commercially Important Species and Sport Fish Species of the Nearshore Zone

The following discussions deal with the abundance, distribution, habitat and spawning requirements, age composition, growth and recruitment of major species which include: salmonids, rainbow smelt, northern pike, muskellunge, carp, goldfish, channel catfish, white bass, smallmouth bass, yellow perch, walleye, blue pike, sauger, mooneye, freshwater drum, emerald shiner, spottail shiner, silver chub, alewife, and gizzard shad.

Information on abundance has until recently been based only on commercial landings or personal conjecture. Recruitment data has formerly been derived from year class dominance in commercial landings. To obtain more accurate data, the Ohio Department of Natural Resources, Division of Wildlife, beginning in the late 1950's, has annually monitored the relative abundance of major game species through trawling and gill netting index surveys. Figure 3 shows the location of the trawling and gill netting stations selected by the Division of Wildlife. Some key references for this section on fisheries are the Ohio Division of Wildlife Dingell-Johnson project F-35-R performance reports, authored by various investigators since 1962. These reports provide indices of seasonal abundance, growth rates, maturity, and recruitment of walleye, yellow perch, white bass, and channel catfish through monitoring of incoming year classes (number of young-of-the-year (YOY) caught per trawling hour).

Salmonids

Lake trout, lake herring, and lake whitefish were important, highly valued commercial species which declined to commercial extinction after 1900 due to a combination of overfishing, siltation of spawning areas, decreasing seasonal dissolved oxygen levels, and an increasing trend in water temperatures (Trautman, 1957; Scott and Smith, 1962; Regier et al., 1969; Van Meter and Trautman, 1970; Applegate and Van Meter, 1970; Hartman, 1973).

The lake trout, a long-lived, slow-growing, and late-maturing species, was endangered by 1950 and is now considered extirpated from Lake Erie. It was common before 1850 in deep eastern basin waters and spawned in shallows around rock and gravel reefs (Trautman, 1957).

Lake whitefish and lake herring (cisco) stocks are extremely depleted. Annual Ohio landings of lake herring were as high as 28.7 million pounds in 1889, fell to 13.4 million pounds in 1917, and then to less than 100,000 pounds in 1925 (Van Oosten, 1930). Landings remained low, increased to 1.6 million pounds in 1946, then declined to commercial extinction by 1970 (Figure 4).

Lake whitefish are only occasionally found on Kelleys Island shoals in late fall and probably other reef areas in the Bass Islands (Hartley and Van Vooren, 1977). Though open lake, pelagic species, they are especially common in the nearshore zone during spawning season. Major western nearshore spawning areas once included the Detroit River and Maumee Bay (Langlois, 1954). Remnant populations may spawn and feed in the nearshore zone today. Efforts to supplement lake whitefish populations by stocking have failed.

Various salmonids have been stocked in Lake Erie to supplement natural production. Species cultivated for stocking programs of nearshore significance include lake whitefish, lake trout, rainbow trout, coho salmon, chinook salmon, kokanee salmon, and Atlantic salmon. These stocking efforts have failed or have been discontinued except for the coho, chinook, steelhead, and lake trout programs.

The objectives of salmonid plantings are to improve the sport fishery, replace lost or depleted stocks of top predators such as walleye and blue pike, and enhance recreational use of coastal areas. These programs have not established self-sustaining salmonid stocks but have been moderately successful on a "put and take" basis (Hartman, 1973).

Distribution and Habitat Requirements. Introduced salmonids are pelagic species of the open, deepwater areas, but depend on shallow gravel or rocky areas along the shore or in tributaries where they spawn in spring or fall. Nearshore areas close to planting sites (Table 16) are probably more heavily utilized by the fish than other nearshore areas.

The Ohio Department of Natural Resources, Division of Wildlife, studied coho salmon from 1969-1971 (Baker, 1971) and found them at warm water outlets near Cleveland and Lorain during winter; during spring, coho were most prevalent along the south shore of the western basin and in Sandusky Bay and Maumee Bay. Coho moved to the north shore of the western basin during early summer and migrated progressively east before returning to the south shore in fall. Just prior to spawning, coho are found off the mouths of parent streams and additional streams where straying occurs.

Rainbow Smelt

Abundance. The abundant adult is primarily an inhabitant of deepwater regions of the eastern and central basins (MacCallum and Regier, 1970). Commercial and recreational facilities have been highly developed since smelt were first reported in Lake Erie during the 1930's. Smelt were first observed spawning in Lake Erie in the 1940's and were considered abundant by the 1950's.

Distribution and Habitat Requirements. Some adults move into shallow, nearshore waters and tributaries to spawn while others spawn in deep water (9-22m) in March and April, depending on location (Trautman, 1957). Most spawning areas are in the Canadian, New York, and Pennsylvanian waters of Lake Erie. Neither adults nor young-of-the-year (YOY) show a tendency to remain nearshore after spawning.

Distribution patterns for larvae in the western basin indicate that spawning probably takes place on the clean gravel bottoms in Canadian waters (Reutter et al., 1978). Larvae are carried southward by Detroit River flow. They are seldom found nearshore in bays where turbidity is high. Some smelt eggs have been found on shoals around the Bass Islands, where post-spawning adults can also be found.

Northern Pike and Muskellunge

Abundance. Drastic decreases in abundance as early as 1830 continued and by 1970 both species were quite rare throughout Lake Erie. This decline has been attributed to overfishing and draining and obstruction of spawning marshes. The muskellunge is still rare (although a sport fishery exists in the upper Niagara River) and the northern pike is common enough to provide a minor sport fishery in the western basin.

Distribution and Habitat Requirements. The muskellunge prefers deeper nearshore waters of the western basin and spawns primarily in vegetated areas adjacent to large tributaries such as the Maumee River and the Detroit River. Spawning is in marshes, inundated woods and flooded prairies soon after or during ice break-up (Trautman, 1957). These wetland areas are the nursery habitats of YOY during the summer. Recent studies may be redefining the spawning habitat of Great Lakes muskellunge populations. Haas (1978) showed that the spawning habitat of muskellunge in Lake St. Clair is quite different from that described above. The Lake St. Clair spawning areas are in open water with a minimum depth of 3m and have very little or no vegetation until midsummer. Water and wind induced currents are quite strong. Harrison and Hadley (1978) reported nearly exclusive use of lotic environments by muskellunge of the upper Niagara River with typical currents averaging 1m/second.

The northern pike prefers shallower, heavily vegeta[illegible] waters. Spawning is in weedy flood plains of rivers and in marshes an[illegible] [illegible]ays. The better known western basin spawning areas are in Old Woman [illegible]ek, [illegible]ron River, Wolf Creek, East Harbor, Turtle Creek, Sandusky Bay, and the Maumee River.

Both species are predominantly found in nearshore and inland waters, utilizing the marshes of western Lake Erie. The scarcity or inaccessibility of suitable wetland spawning areas has limited their abundance. Further reduction of wetlands could result in the extirpation of these species

Carp and Goldfish

Abundance. After importation from Europe in the late 1800's for food and ornamental purposes, both species reproduced prolifically and are now abundant. Goldfish have little to no value and carp are environmentally a destructive pest, but also a heavily harvested and commercial fish in western Lake Erie. Figure 5 shows the Ohio commercial production of Lake Erie carp from 1914-1976. The largest market for Lake Erie carp has historically been in large eastern cities where carp is used in ethnic dishes (gefilte fish). Small local markets exist for smoked carp. Carp are now also being used for stocking fee fishing ponds and for fish meal and fish sausages.

Distribution and Habitat Requirements. Carp and goldfish are nearshore and inland water species most abundant in warm silty, low-gradient waters of bays, marshes, and estuaries (Langlois, 1954; Trautman, 1957). Spawning occurs in warm, weedy or grassy shallows in late May to August. Fall concentrations occur in deep water near the Bass Islands. Hybridization between the two species is common. Chironomid larvae, oligochaetes and diatoms are their major dietary items (Hartley and Herdendorf, 1975).

The broad spawning period and short egg incubation period of these warm-water species minimizes exposure to sedimentation, low oxygen, disease and predation and therefore has contributed to their great abundance.

It is often the more undesirable species which find the present, man-disturbed habitats suitable for their reproduction and growth and consequently become most numerous (Trautman, 1977).

Channel Catfish

Abundance, Distribution, and Habitat. The channel catfish is an important commercial and sport fish. It is common throughout the lake and is most abundant in the nearshore and low-gradient inland waters of the western basin on sand or gravel bottoms (Trautman, 1957). The highly migratory adults ascend bays and tributaries to spawn in June through July. Some known spawning areas are the Sandusky Bay, Maumee River, and Portage River.

Spawning occurs in dark nests, holes or log jams in shallow, turbid waters. The cryptic habits of YOY make accurate determinations of abundance and movements difficult. After hatching, they appear to descend tributaries and distribute throughout bays, estuaries, and the nearshore zone. Adults, after spawning, move offshore in late summer and early fall (Van Vooren and Davies, 1974). They overwinter in deeper offshore waters, particularly around the Bass Islands and Kelleys Island.

The range of the channel catfish extends beyond the nearshore zone, but this area is of clear seasonal importance as a spawning ground and as a feeding ground for young.

Food Habits. Channel catfish are bottom feeders. Hartley and Herdendorf (1975), in a study of food habits in Sandusky Bay, indicated that channel catfish are omnivorous, feeding on fish, dipteran larvae, oligochaetes, and cladocerans. Price (1963) collected channel catfish from Sandusky Bay as well as the open waters of Lake Erie in the island region and found midge larvae and pupae were the most important dietary items of a large variety of food organisms.

Age at Maturity and Age Composition. Channel catfish mature over a wide range of ages and sizes. DeRoth (1965) found catfish of both sexes reaching initial maturity at ages II through VII, with at least 50 percent mature at age V for both sexes. Initial maturity occurred over a range in size from 229 mm to 432 mm for males and 178 mm to 457 mm for females.

Age composition is shown in Table 17. Figure 6 shows the location of the net run sampling sites from which the major commercial species were taken. Percent female, percent legal size, mean length and mean age were determined for fish in these net run commercial samples. The 1973 and 1971 year classes ranked first and second in the western basin for 1978 samples taken by Ohio Department of Natural Resources, Division of Wildlife (Davies et al., 1979).

Commercial Harvest. Commercial harvest of channel catfish in the nearshore zone has been greatest in spring along the shore between Toledo and Sandusky, particularly in Sandusky Bay (Figure 7). Over 95 percent of spring commercial production occurs along the south shore of the western basin and Sandusky Bay.

Commercial catches and catches from Ohio Division of Wildlife gill net stations indicate a steady decline since the 1950's (Figure 8). From 1970 - 1978, numbers captured by trawling and gill netting were highest in 1974.

Sport Harvest. Only three percent of the total angler hours in 1975 - 1977 were expended seeking channel catfish. The greatest harvest occurred during May, June, and July when channel catfish were in the nearshore waters for spawning. Table 18 shows channel catfish sport harvest from 1975-1977 as determined in an Ohio Division of Wildlife creel survey. Figure 9 shows the creel survey grid and district system.

White Bass

Abundance. The white bass is a major game fish and has increased in commercial importance since the decline of commercial walleye harvests. Despite heavy exploitation, no progressive decline in white bass stocks has been evident, but white bass do, however, experience fluctuations in abundance (Van Vooren et al., 1978, 1977, 1976, 1975; Davies et al., 1979).

Distribution and Habitat Requirements. The white bass is a highly mobile benthic pelagic species and ranges from inland waters into the nearshore zone and far offshore (Trautman, 1957; Van Vooren and Davies, 1974). White bass are especially

abundant in the western basin. White bass spawning occurs during spring on rocky shoals in lakes, rivers, bays, and on reefs. White bass are free spawners (do not build a nest) and the eggs are deposited and fertilized in midwater and sink to adhere to some surface. The Sandusky River and Maumee River provide spawning habitat. Within the western basin, white bass larvae are found almost exclusively in the Sandusky and Maumee Bays.

Because of the large numbers of larvae found in the tributary rivers, the primary spawning grounds are probably not the bays (Reutter et al., 1978). Larvae found in the bays may originate in the rivers and flow downstream to the bays with river currents. The bays do, however, serve as important nursery areas.

YOY first appear in nearshore trawlings from early June to July. Dense YOY concentrations were found during the summers of 1974 - 1977 in Sandusky Bay, East Harbor, and in the vicinities of Bono, Ohio and Monroe, Michigan (Van Vooren et al., 1978, 1977, 1976, 1975). By October, the denser concentrations are found in the central basin. Yearlings remain in the nearshore zone during spring, summer, and fall. Adults are distributed throughout the western basin during summer, fall, and winter, with a dense (possibly spawning) concentration in the reef area of the Bass Islands during spring. The nearshore zone, especially in the western basin, is an essential feeding, spawning, and nursery area for all ages of white bass.

Food Habits. Major dietary items are fish, mostly minnows, and dipteran larvae and cladocerans (Price, 1963; Tubb, 1973; Griswold and Tubb, 1974; Hartley and Herdendorf, 1975).

Sport Harvest. The area of concentration for Ohio's white bass fishery was historically located in the western basin near the reef and island areas. However, during the Ohio Department of Natural Resources 1975 - 1978 sport fishery survey, this area contributed only 10 percent of the summer harvest. The majority of the sport harvest of white bass was concentrated in thermal plume areas created by industrial hot water effluent. Seventy-five percent of the sport harvest occurred at Avon Point, Lorain, Cleveland, and Eastlake. Reutter and Herdendorf (1976) have predicted that all of 24 common Lake Erie species tested for temperature preference will be attracted to an anticipated warm water plume at Locust Point during fall, winter, and spring. White bass were concentrated at thermal plume areas during most of the summer. Table 19 shows the 1975-1977 sport harvest of white bass by the district and grid system shown in Figure 9.

Commercial Harvest, Age Composition, and Age at Maturity. The Ohio Department of Natural Resources, Division of Wildlife, annually describes population trends and harvests of the major sport, commercial and selected forage species of Lake Erie. Trawling and gill netting at various stations throughout Lake Erie (Figure 3) have shown a continuous decline in adult numbers following the lifting of a two year (1971 - 1972) imposed reduction in commercial fishing exploitation. In the 60's, the age composition was such that very few individuals were older than age IV. From 1965 to 1970, less than four percent of the white

bass captured in survey gill nets were older than age III and none were older than age V. Average age during this period never exceeded 24 months. After the two year reduction in commercial exploitation, age composition increased drastically. In 1974, 84 percent of white bass captured during surveying had survived four or more years. Average age was 47 months. Age VIII fish were found in every commercial sample examined in spring 1976.

Age composition is now decreasing and is predicted to return to that typical in the 1960's (Hartley and Van Vooren, 1977). Age composition of the 1975 - 1978 western basin sport harvest was predominantly ages II and III during May, June, and July. This coincides with the assessment of the relatively low numbers of adult white bass in western Lake Erie (Van Vooren et al., 1977). Age composition for 1978 samples collected by the Ohio Division of Wildlife is listed in Table 20.

Growth of white bass since 1965 has shown no increasing or decreasing trends. Male white bass spawn at age II and females spawn at age III. Because the 1977 year class was exceptionally high, the 1979 spawning population is expected to be higher than in 1978. The large number of maturing yearling females in the population will compensate for the absence of larger and more fecund females in the older age groups. Figure 10 shows the trends in commercial and sport harvests of white bass since 1975 and Figure 11 shows the fluctuation in commercial production of white bass in Ohio waters of Lake Erie since 1915. The monthly distribution of white bass commercial harvest as reported to the Ohio Division of Wildlife is shown in Figure 12.

Smallmouth Bass

Abundance. The continuous decline and commercial extinction of smallmouth bass stocks has been attributed to overfishing, siltation of spawning areas, and the obstruction of tributary spawning runs by dams. The smallmouth bass is especially important to the sport fishery of the Bass Islands region.

Distribution and Habitat Requirements. The smallmouth bass is mostly a nearshore species occurring along the entire Lake Erie shore, but is most abundant around the limestone reefs and bars of the Bass Islands (Trautman, 1957). Spawning occurs in shallow water over coarse gravel in the nearshore zone, offshore reefs and tributaries from early May to late June depending on water temperature. Nests can be constructed at depths between 0.6m - 6.7m provided some current is present and the water relatively clear. Nests at depths less than 1.5m are subject to disruptive wave action and at depths greater than 1.5m are susceptible to siltation (Barnes, 1979). The male fish guards the nest and young for a short time.

Recaptures showed that smallmouth bass seldom migrated beyond 3.2 km from the point where they were captured and tagged in a study conducted in the Bass Islands region (Hair, 1978). Adults moved to preferred island nearshore spawning areas in spring, returning to the same general areas used the previous spring. After spawning, adults returned to nearshore reefs and adjacent deep water where they remained the rest of the year.

The nearshore zone provides habitat and feeding grounds for adults; sheltered bays and tributaries provide spawning grounds and nursery areas. Open, wave-swept beach areas are of minimal importance to this species.

Food Habits. YOY feed on copepods, immature diptera, ephemeroptera nymphs, amphipods, and fish; yearlings and adults feed on fish and crayfish (Hair, 1978).

Age at Maturity. Male smallmouth bass are recruited into the spawning population at age III at lengths as small as 243 mm. Some females are mature at age III at lengths as small as 261 mm, and all are mature at age IV (Hair, 1978).

Sport Fishery. The popular smallmouth bass sport fishery is mostly in the reefs and bars of the Bass Islands region. Table 21 shows the 1975-1977 sport harvest; see Figure 9 for Ohio Division of Wildlife creel survey grid and district system.

Yellow Perch

Abundance. The yellow perch is an important commercial and sport fish. Most of the sport harvest occurs in the western basin and most of the commercial harvest in the central basin. Yellow perch are abundant throughout the lake. Commercial pressure on yellow perch increased as stocks of whitefish, cisco, and blue pike declined. Strong consecutive year classes helped to make yellow perch the dominant Lake Erie fishery by the late 1950's, but since then year class strengths have greatly fluctuated.

Distribution and Habitat Requirements. Yellow perch are most abundant in the clearer, shallow waters of the island region. Although they can be found at various depths and in more turbid waters such as Sandusky Bay and Maumee Bay. Yellow perch are not strictly nearshore fish (Trautman, 1957; Van Meter and Trautman, 1970).

Spawning occurs in mid-April to late May in three to eight feet of water (Scott and Crossman, 1973). Gelatinous, adhesive ribbons of eggs attach to submerged vegetation, twigs and various other surfaces in sheltered weedy, sandy or gravel nearshore shallows (Langlois, 1954; Sztramko and Teleki, 1977).

Larvae are found mostly in the nearshore area and appear to be concentrated near the bottom (Reutter et al., 1978). Inshore areas where larvae are found have a sandy to gravel bottom with Cladaphora the dominant vegetation.

YOY first appear in Ohio Division of Wildlife nearshore trawls during mid-June. Dense YOY concentrations may be found in Sandusky Bay, Cedar Point, and East Harbor. By October, the densest concentrations of YOY were offshore in the island region and in the central basin. Numbers of yearlings and adults in the nearshore zone show variable trends in nearshore abundance: they sometimes increase from spring to fall then are decreasing until the following spring, and at other times decrease from spring to fall then increase to the next spring.

The nearshore zone furnishes spawning and nursery areas and is seasonally important as a concentrating area for adults and yearlings.

Food Habits. Seasonal differences in feeding habits, especially of the larger fish, reflect numbers and availability of various types of food organisms. From a springtime diet of wide variety, perch in the summer take fewer leeches, amphipods, mayflies, and fish eggs, and increase their consumption of cladocera, midges, fingernail clams, and other fishes. During the autumn they renew their intake of leeches and, as the populations of aquatic insects decrease, perch feed more heavily on ostracods, amphipods, and fishes than at any other season. Perch eat practically any available animal food associated with submerged vegetation in shallow water, bottom or surface waters (Price 1963).

Age, Growth and Maturity. The age, growth, and maturity of yellow perch have been annually studied by the Ohio Division of Wildlife and summarized in Dingell-Johnson Project F-35-R annual performance reports. Information on the age and size composition of yellow perch in commercial catches has been collected annually by state, federal, and provincial agencies.

Age composition of yellow perch captured by Ohio Division of Wildlife experimental trawling since 1960, though somewhat dependent on individual year class strengths, has typically been dominated by fish younger than age III. Very few fish older than age IV were captured, probably less than 2 percent. Age composition varies between different portions of the lake presumably due to variations in recruitment, growth and entry into commercial fishery. Age composition is shown in Table 22. Yellow perch in the western basin generally have an older age composition than perch in the central basin.

Current growth of yellow perch varies over different portions of the lake with perch in the western basin exhibiting the slowest growth.

Baker (1965) determined time of maturity for Lake Erie yellow perch collected from 1900 to 1964. He found that males matured at 112 - 193 mm with fifty percent mature at less than 127 mm, and females matured at 132-213 mm with fifty percent mature at approximately 178 mm. These lengths correspond to maturity at age II for males and age III for females. The age and size at sexual maturity has varied little since the early 1960's.

Sport and Commercial Harvest and Recruitment. Commercial harvest of yellow perch is greatest in nearshore waters of the central basin during May and September through October. Figure 13 shows the monthly distribution of yellow perch commercial harvest. Records of Ohio commercial harvest of yellow perch indicate a sharp decline in production in the last two decades (Figure 14). The close correlation between the sport and commercial annual harvests suggest the sport harvest has experienced a similar decline. Tables 23 and 24 show the yellow perch sport harvest from 1975 - 1978. Refer to Figure 9 for the district and grid system used in Table 24.

Yellow perch was the most sought after sport species on Lake Erie during a creel survey conducted by the Ohio Department of Natural Resources, Division of Wildlife from 1975 - 1978. The yellow perch catch was 65 to 68 percent of the annual sport harvest of all species. Boat anglers in western basin shoals spent the most time and caught the most fish in August, September and October. The shore angler harvest was more evenly distributed throughout the summer with a minor seasonal peak in May and June. This early summer harvest resulted from the availability of yellow perch in nearshore waters during spawning.

The presence of subpopulations has been suggested, but it is not known to what degree various suspected subpopulations mix and cross jurisdictional boundaries. An Ohio Division of Wildlife tagging study is currently determining yellow perch population mixing, range distribution, and relative contribution and susceptibility to all of the Lake Erie fisheries. Improved management of yellow perch is the study objective.

The numbers of yearlings and adults in recent years have been consistently low. In the fall of 1976, the numbers of yearlings and adults were the best in five years, but only one-fourth the numbers present in 1967. As depressed as yellow perch stocks are, they would still be considered an abundant species.

Recruitment since 1965 has been generally poor (Hartley and Van Vooren, 1977). Hatches in 1970, 1971 and 1975 were the better of recent years, but much poorer than the excellent hatches of the 1950's and early 1960's.

Walleye

Abundance. Commercial fishing increased for walleye, blue pike, sauger, and yellow perch after salmonid production declined (Figure 15). The once lucrative Lake Erie commerical walleye fishery lasted from 1900 to its collapse in 1963 (Regier et al., 1969). Walleye commercial harvest landings rose from one to two million pounds between 1915 and 1930 to a peak of 5.9 million pounds in 1956, then crashed to 300,000 pounds in 1962. A combination of overfishing, siltation of spawning areas, obstruction of tributary spawning areas by dams, deterioration of dissolved oxygen regimes in the central and eastern basins, and speculatively to predation by rainbow smelt on young-of-the-year (YOY) walleye has been attributed to the decline of walleye stocks (Regier et al., 1969). A commercial fishing ban in Ohio and Michigan was imposed in 1970 to prevent further depletion of the stocks.

Distribution, Movements, and Habitat Requirements. The walleye is distributed throughout Lake Erie but primarily restricted to the eastern and western basins (Langlois, 1954; Trautman, 1957). Tributaries once used for walleye spawning are now largely obstructed by dams or by industrial pollution. Major spawning areas now include only offshore reefs of southwest Lake Erie and the Sandusky and Maumee Rivers. Actual spawning probably occurs only incidentally in the nearshore zone, but spawning runs of walleye must traverse and concentrate in the nearshore zone enroute to their spawning areas in the Sandusky and Maumee Rivers (Fraleigh, 1975).

Spawning areas consist of rocky, rubble, or other firm bottom and the spawning season begins in early spring, when the desired water temperature is achieved (Newburg,1975). Spawning may occur as early as March 31 and as late as April 15, peaking during the third week of April (Van Vooren, 1978). Walleye are free spawners (do not build a nest). Fertilized eggs sink and adhere to stones, sticks or vegetation.

After spawning, adult walleye in the western basin move gradually offshore and move both eastward and westward along the northern and southern shores of Lake Erie, eventually returning to their western basin spawning grounds (Wolfert, 1963; Ohio Division of Wildlife, 1971; Van Vooren, 1978). During summer and early fall, walleye are generally distributed in the shoal and island areas. During the fall, they can be found in deep water (10 m to 11 m) over a mud bottom. Walleye overwinter in deep water, particularly around the islands.

Recaptures on the spawning grounds of fish tagged the preceeding year showed walleye populations to be very discrete (Wolfert, 1963). Limited sampling on Lake Erie reefs indicated spawning populations are even discrete to a particular reef.

Juvenile walleye moving out of spawning areas tend to concentrate along the lakeshore between Maumee Bay and Sandusky Bay and between the Raisin River and the mouth of the Detroit River (Parsons, 1972). Age 0 to age I walleye tend to move westward toward the Michigan shore in up to 6 m of water and into the Detroit River, Lake St. Clair and St. Clair River (Wolfert, 1963).

Walleye larvae are found in areas similar to those preferred by yellow perch; inshore on sandy to rocky substrates. The southerly flow of the Detroit River across spawning reefs could be depositing the larvae found inshore between Locust Point and Catawba Point (Reutter et al., 1978). Plate 1 shows the reefs of western Lake Erie (from Herdendorf, 1970). Large numbers of larvae on Niagara Reef indicate that these reefs are being used for spawning.

The nearshore zone functions as a migration route, spawning concentration area, nursery area, adult walleye habitat and as spawning grounds of undetermined importance (Barnes, 1979).

Sport Fishery. Walleyes provide a very popular recreational fishery in the western basin. An estimated 1.6 million walleye were harvested in the sport fishery in 1978, a 24 percent decline from the record 2.2 million harvested in 1977 (Tables 25, 26, and Figure 9).

Walleye fishing in Lake Erie from 1975-1978 was greatest during June, July and August, when angler success for most other species was lowest (Baker et al., 1979). Lake Erie boat angling was directed mostly at walleye and concentrated on major western basin reef areas. Figure 16 shows that the greatest walleye sport harvest (1978) occurred near West Sister Island. The decline in successful walleye angling after the July peak was possibly influenced by an increased availability of the

year's hatch of gizzard shad and emerald shiners forage. Van Vooren et al. (1977) noted a correlation between high catch rates of walleye in 1977 and low forage abundance assessment for 1976. Forney (1960) also reported a relationship between low forage and increased walleye vulnerability to angler harvest.

Recruitment. Ohio Department of Natural Resources summer trawling indices from 1973-1978 indicate the presence of significant year classes in 1974, 1975, and 1977. Young of the year recruitment for 1978 was poor and the age I fish (1977 year class) were abundant (Table 27).

Age, Growth and Maturity. In October, when yearlings become susceptible to gill net survey gear, yearlings accounted for 73 percent of the Age I and older population. The age II and older (adult) population was about half as abundant as it was in 1977 (Davies et al., 1979). In 1973, all age III female walleye were in the spawning population; in 1977 only fifty percent were spawning and in 1979 no age III female walleye are expected to be in the spawning population. This increase in age at maturity is suspected to be density dependent. Growth, however, which is also thought to be density dependent has not been depressed as has maturity. Mean lengths at age for October 1978 were comparable to those measured in the previous five years. The reasons for this constancy in growth are as yet unknown.

Age composition for walleye in Ohio Division of Wildlife 1978 net run samples is in Table 28.

Despite the reduction in the adult age group, mean biomass of the spawning population in 1979 is predicted to be higher than in 1978 due primarily to the strong 1975 year class. Relatively strong year classes have been produced recently by small spawning populations.

Food Habits. Walleye are essentially piscivorous, feeding primarily on smelt, alewife, gizzard shad and various minnows (Price, 1963).

Blue Pike

The taxonomic status of the blue pike has been disputed since its description by Carl Hubbs in 1926. It is now considered to be a subspecies of the walleye. No fish in Lake Erie has shown a more rapid decrease from former abundance to present extirpation (Trautman, 1977).

It was abundant in the deeper, clearer waters of the central and eastern basins and contributed greatly to the commercial fishery. The commercial catch was over three million pounds in 1885 (Smith and Snell, 1891), fluctuated wildly from 1950 to 1957 and rapidly collapsed after 1955 (Figure 17). 79,000 pounds were harvested in 1959 and in 1964 only 200 pounds were harvested (Applegate and Van Meter, 1970).

Sauger

Abundance. The sauger was a commercially extinct species by 1960 (Figure 17). Sauger commercial harvests had been as high as 6.2 million pounds in 1916. Overfishing, siltation of spawning areas, damming of streams used for spawning and cultural pollution contributed to the decline (Trautman, 1957; Van Meter and Trautman, 1970; Hartman, 1973; Regier et al., 1969). Introgressive hybridization with the more abundant walleye may have eliminated the pure sauger strain from Lake Erie. Until 1963, the sauger was important as a sport fish. The Ohio Department of Natural Resources is currently and with some success stocking sauger in the western basin (Rawson and Scholl, 1978).

Distribution and Habitat Requirements. Native sauger were most abundant in the western basin. Stocked sauger released as fry and fingerlings into Lower Sandusky Bay moved out of the bay and occupied shore areas along the entire western basin, particularly between Sandusky Bay and Monroe, Michigan. Areas of heaviest concentration included Sandusky Bay, Sandusky River, Maumee Bay and the vicinity of Locust Point. The vast majority of recaptures from recent sauger stockings have been in Sandusky, which had never been listed as a major concentration area for native sauger. The seeming preference of stocked sauger for Sandusky Bay may be the result of a homing tendency and future distribution could be affected by varying the point of reintroduction (Hartley and Van Vooren, 1977).

Native sauger spawning occurred in late March and early April along shale ridges and sand-gravel substrates in the Sandusky River and along cobble-boulder riffles in the Maumee River. Mud bottoms are not suitable for spawning. After spawning, sauger remained in turbid nearshore areas. Maturity is reached at age II in both sexes.

Introduced sauger seem to remain segregated from walleye except in the river spawning areas. Sauger preference for more turbid waters and a greater nearshore orientation tend to keep them segregated from walleye. Capture of 1977 year class sauger showed that some limited natural reproduction had occurred among introduced sauger (Rawson and Scholl, 1978). Growth has far exceeded the known historical growth rates of native sauger.

Mooneye

The mooneye is shore-oriented and once was a minor part of commercial and sport catches (Van Oosten, 1961; Miller, 1972). It is now so depleted as to be officially protected by Michigan and Ohio. The decrease in abundance has been attributed to siltation (Trautman, 1957).

The mooneye is not limited to the nearshore zone, but will seldom occur in waters deeper than 10.7 m. It prefers clear waters and feeds mostly in flowing waters (Trautman, 1957). Detailed spawning information is lacking, but spawning is probably in river pools, ponds, and backwater lakes in late spring to early summer (Johnson, 1951). The nearshore zone is probably a spawning, nursery and feeding area.

Boesel (1938) found that mooneye fed mostly in flowing waters on a variety of planktonic, benthic and terrestrial invertebrates and small fish.

Mooneye reached age VII and ranged in average size from 124 mm at age I to 324 mm at age VII. Maturity was reached after age II (Van Oosten, 1961).

Non-game Fish Species of the Nearshore Zone

Freshwater Drum

Abundance. Freshwater drum (sheepshead) are abundant and widespread throughout Lake Erie and believed to be increasing. This species is held in low esteem by sport and commercial fishermen; inadequate national marketing precludes a sustained demand for drum. A change in consumer attitude would increase the value of this fish. This situation is reminiscent of the change at the turn of the century from a preference for whitefish, cisco and blue pike to the "inferior" yellow perch as stocks of the preferred species diminished. Recent commercial catch statistics show an increase in commercial production of drum (Figure 18), possibly indicative of changing consumer attitude.

Distribution and Habitat Requirements. Adult drum inhabit a wide range of depths and bottom types, but they are especially common in the shallow waters of the western basin (Trautman, 1957; Daiber, 1952). It is common along the entire Lake Erie shoreline and in almost all embayments and river mouths in both clear and turbid water (Edsall, 1967).

Exact spawning locations are unknown, but are thought to be in diverse habitats including bays, tributaries and open lake over sand or mud to water depth of 2 m (Daiber, 1953). The long spawning period is from early June to mid-September. The freshwater drum is the only species in the Great Lakes which produces a pelagic egg. Drum eggs and pro-larvae contain a large oil globule which causes them to float near the surface. They can therefore survive in areas where oxygen tensions are low in the bottom waters. Plankton, which concentrate in surface areas, become a readily available food source. The abundance of drum in Lake Erie may be in part due to these early life stage characteristics.

YOY are widely distributed in bays and tributaries as well as deeper lake waters.

Food Habits. Freshwater drum feed on dipteran larvae, oligochaetes, zooplankton and small fish (Tubb, 1973; Griswold and Tubb, 1977; Hartley and Herdendorf, 1975). Drum feed on plankton, mostly crustaceans, until they reach a length of more than 20 mm, after which they concentrate on benthos (Daiber, 1952).

Commercial and Sport Harvest. Only limited, mostly local markets exist for Lake Erie drum. The 1975-1977 sport harvest of drum is in Table 29. See Figure 9 for commercial fishing grids and districts. Drum are sold whole, scaled and undressed

in Detroit, Cleveland and neighboring areas. A rendering plant in Cleveland processes drum into meal and oil but purchases only a small percentage of the commercial catch (Snyder, 1979). The current price for drum is only 1 3/4¢ per pound, which is one reason why most drum landed by commercial fishermen are released.

Emerald Shiner, Spottail Shiner, Silver Chub

Abundance. Emerald and spottail shiners are not recreationally or commercially important, but are abundant, important forage species for larger predatory commercial and game species. These species are commonly used as bait fish.

The silver chub was once an abundant forage species but has now been placed on the Ohio Endangered Species List.

Distribution and Habitat Requirements. The spottail shiner prefers shallow water (Trautman, 1957; Wells and House, 1974). It is essentially shore-oriented and common both nearshore and offshore throughout Lake Erie. They are abundant in open beach areas, harbors and tributaries, using the nearshore zone for feeding and spawning. They apparently avoid areas where the bottom is composed of flocculent, clayey silts, especially favoring the rocky areas around the Bass Islands. Spawning occurs on sandy shoals from early June to late July (Wells and House, 1974).

Bottom type is not particularly important to the abundant emerald shiner. It seldom comes in contact with the bottom and tends to remain in midwater avoiding rooted aquatic vegetation and coming to the surface at night to feed. Larvae are found in highest numbers in the least turbid and open water portions, especially in the deeper water adjacent to rocky reefs (Reutter et al., 1978).

The silver chub occurred in greatest abundance before 1955 in clean gravel and sand bottom waters of the island region (Trautman, 1957). Siltation was probably a major factor in the decline of this species. Its drastic decline was coincidental with the decrease and virtual extirpation of the mayflies of the genus *Hexagenia*.

Food Habits. The spottail shiner feeds opportunistically on a variety of phytoplankton and zooplankton (Wells and House, 1974).

Age Composition and Maturity. Both sexes of spottail shiner spawn by Age II. Size, rather than age, determines time of maturity. YOY are the dominant age group in spottail shiner and emerald shiner populations because older age groups experience higher mortality. Most spottails in western Lake Erie are ages 0 to II. Maximum age for males is III and for females, age IV.

Recruitment. The numbers of spottail shiners have shown no general increasing or decreasing trends during the period of record. Annual numbers vary considerably due to their short life span (Table 30). Figure 19 shows the location of the districts referred to in Table 30 as delineated by Ohio Division of Wildlife. Recruitment also varies considerably.

Emerald shiner populations showed a tremendous increase during the early 1960's and have since been high, fluctuating annually with recruitment. However, numbers of yearlings and adults in 1976 was the lowest since 1960 (Table 31 and Figure 20). Recruitment was poor in 1975 and in 1976 was the poorest since 1958.

Alewife and Gizzard Shad

Abundance. Small gizzard shad and alewife are important forage fish for game and commercial species. The short-lived alewife is considered a nuisance due to annual die-offs, but is still an important forage food source. Both species are abundant in Lake Erie (Trautman, 1957; Bodola, 1966; Van Meter and Trautman, 1970).

Distribution and Habitat Requirements. The adult alewife is primarily a deepwater, pelagic species of the open lake and seldom enters shallow waters or tributaries except to spawn in late spring in shallow beaches, harbors, ponds and quiet rivers (Langlois, 1954; Trautman, 1957). YOY are the most abundant age group found in the nearshore zone, which serves to some extent as a spawning and nursery area. During spring, distribution is limited almost exclusively to the shallow western basin. Fall distribution is more general, with a prevalence at depths of 18 m - 24 m in the central basin.

The gizzard shad is primarily a nearshore species and thrives in warm, low-gradient waters with abundant plankton. It is very tolerant to turbidity. Spawning is dependent on water temperature and occurs in the spring, probably over sand and gravel bottom, in about 1 m of water (Bodola, 1966). The eggs are denser than water and are adhesive. They are scattered and sink to adhere to stones, plants or other surfaces. Gizzard shad are especially abundant in the shallow periphery waters and bays of the western basin during most of the year, but they move to deeper water during fall.

Age, Growth and Recruitment. Age composition of alewife is extremely young. Almost all gizzard shad males and about 80 percent of the females are mature at age II. Recruitment during the 1970's was exceptionally good. Growth of gizzard shad in Lake Erie is extremely rapid.

Other Lake Erie Fish Species and Their Habitat Associations

Habitat associations, distribution and relative abundance of fishes found in the nearshore zone are not uniform and not always predictable. Species or groups of species can be restricted to one or more habitat types, or, they are tolerant of many different types of habitats and are not so restricted. Since habitat preferences of most Lake Erie fish species are known (Nash, 1950; Langlois, 1954; Trautman, 1957; Harner, 1958; Van Meter and Trautman, 1970; Scott and Crossman, 1973), the occurrence and relative abundance of most species in a previously unsampled area can be predicted with some degree of accuracy.

Lake Erie habitats are basically of two types: sheltered or unsheltered from wave action (Barnes, 1979). Unsheltered habitats are beaches or bluffs directly subject to constant or intermittent wave action. Few coastal areas are totally sheltered except for narrow inlets, estuaries, man-made harbors and areas protected by barrier reefs or bars. Nearshore areas near projecting peninsulas, points or man-made structures can at times be sheltered habitat, but a shift in wind direction can change the habitat to an unsheltered type.

The Lake Erie unsheltered nearshore areas are extensive, but do not support a diverse fish fauna. Cover and vegetation are minimal and the hard bottoms are bedrock, cobbles, boulders, gravel, sand or hard clay. Species which are common to abundant in exposed habitats are listed in Table 32. Species common to abundant in unsheltered areas with some amount of structure present such as reefs, boulders, riprap, and land projections to the windward are listed in Table 33. These structures provide some cover and interrupt waves. Species once common in unsheltered nearshore habitats but now depleted because of overfishing or siltation of clean sand or gravel bottoms are listed in Table 34.

The western basin has most of the sheltered nearshore habitats (inlets, estuaries, harbors, wetlands, areas protected by barrier bars) in Lake Erie. The diversity of habitats and species is great. Barnes (1979) and Hartley and Van Vooren (1977) classified sheltered nearshore habitats as: 1) vegetated or unvegetated, 2) hard bottom or soft bottom, 3) lentic or lotic. Most species found in unsheltered habitats can also be found either perennially or seasonally in sheltered nearshore waters. Seasonal species are the most abundant during spring and early summer when they seek shelter for spawning. These seasonal species are listed in Table 35. Channel catfish, white bass, sauger, walleye, yellow perch and freshwater drum generally remain in sheltered waters throughout the year while the abundance of other species is highly seasonal.

Species perennially common in sheltered habitats are those generally associated with aquatic vegetation. Vegetation-dependent species which need clean sand or gravel bottoms are the lake chubsucker and the tadpole madtom. Vegetation-dependent species which tolerate a variety of bottom types, provided turbidity is minimal, are listed in Table 36. Species not largely dependent on vegetation but common in shallow turbid waters with soft bottoms and abundant vegetation are carp, goldfish, gizzard shad, white sucker, black bullhead and white crappie. Species not dependent on vegetation, but often associated with aquatic vegetation in clear, shallow water with sand or gravel bottoms are listed in Table 37.

Sheltered, unvegetated nearshore waters support a variety of fish species. Species tolerant of many bottom types and turbidity levels and therefore common in most all sheltered areas are listed in Table 38. Other species prefer clearer waters and harder bottoms such as sand, gravel or clay (Table 39). These species may be found in both lentic and lotic waters. Carp, goldfish, bigmouth buffalo, black bullhead and flathead catfish prefer soft bottoms of mud or muck.

Many species are abundant in both sheltered and unsheltered nearshore waters (Table 40).

All other Lake Erie species generally occur in one or two specific habitats. Keep in mind, however, that many species occupy a wide range of habitats and can be found in habitats to which they are not normally ascribed. Fish species will, however, reach their greatest abundance in only one or two types of habitat.

Although habitat associations of nearshore fishes are known and general grouping of species in particular areas or habitats are identifiable, this is only a general knowlege of associations and not of interactive relationships between species. Research in the area of interspecific relationships of nearshore fishes is lacking. Food habits studies have been conducted, but future studies will require greater intensity and duration to actually identify inter-relationships.

Critical Fisheries Habitat

Hartley and Van Vooren (1977) compiled a table of habitat types used by Lake Erie fish species for spawning, nursery, feeding, migration and overwintering. Below each type of habitat is a list of fish species known to use that habitat. It can be inferred from this table the numbers and species of fish utilizing each particular habitat. This same information is also presented differently so as to determine whether a species is listed under several types of habitats or is solely dependent on one type for any particular use. These very useful tables are duplicated here as Tables 41 and 42.

When determining the importance of a certain habitat type to a particular species, i.e. "determining critical fisheries habitat", the following questions should be asked: 1) Is the habitat critical in one or all phases of that species' life cycle? 2) What is the quantity or availability of that habitat? 3) How many species depend on this habitat? 4) How sensitive is this habitat to environmental alterations? 5) What is the biological, sociological or economical importance of the species? A habitat type can be classified as more or less "critical" depending on the answers to the above questions.

Hartley and Van Vooren (1977) delineate on Plates 1a, 2a, 3a and 4a the location and extent of each of the habitat types listed in Tables 41 and 42.

The Ohio Department of Natural Resources, Coastal Zone Management Program (1979), indicates important fish habitat areas of Lake Erie as including all nearshore areas out to a depth of 20 feet, bays, estuaries and offshore shoal areas. Five western basin habitat areas of critical concern are 1) Maumee Bay, 2) Toussaint-Locust Point reef complex, 3) the islands area, 4) Ruggles Reef complex, and 5) Sandusky Bay (including Muddy Creek Bay).

Endangered Fish Species. Siltation, wetland diking and draining, tributary obstruction and overfishing are considered the principal contributing factors in the depletion of the species now listed as endangered. Table 15 indicates which species

are officially protected by law in Ohio. No fish on the Federal (U. S. Department of the Interior) Endangered Species List are generally found in the Lake Erie nearshore zone. The state endangered species found in the nearshore zone are rare lakewide, except the burbot, which Van Meter and Trautman (1970) consider common in the deeper waters of the central and eastern basin. It is protected in Ohio because it is so infrequently found in the shallower waters.

The muskellunge, blacknose shiner, pugnose minnow, banded killifish and Iowa darter are Ohio endangered species dependent on clear waters and abundant aquatic vegetation. The silver lamprey, lake sturgeon, mooneye and longnose sucker, also endangered, are dependent on clear water and unobstructed tributaries for spawning.

The Michigan Department of Natural Resources, Ohio Department of Natural Resources, Pennsylvania Fish Commission, New York State Department of Environmental Conservation and U. S. Fish and Wildlife Service, Twin Cities, Minnesota should always be consulted for current listings of threatened and endangered species before work begins which may involve such species.

Sport Fishery

Nearly 300,000 Ohio licensed anglers fish in Lake Erie and annually spend $60 million on their sport. The Ohio Department of Natural Resources conducted an annual direct contact sport angler survey in 1975, 1976 and 1977 along the Ohio Lake Erie shoreline. The following is a general discussion of their findings.

Lake Erie provides year round angling as various fishes become available at different seasons. Yellow perch are the mainstay of the winter ice fishery (Table 43, Figure 20). River spawning migrations provide angling for walleye in March and April, and white bass in May and June. The summer lake fishery for freshwater drum, channel catfish and smallmouth bass occurs from May through July, with angling for walleye and white bass best in July and August. The yellow perch lake fishery peaks in September and October. Tables 44 and 45 list the shore and boat angler harvests, hours spent fishing and catch rates by species for 1975 - 1977.

Boat fishing in the western basin was concentrated between Locust Point and Cedar Point, especially near Catawba-Marblehead (Figures 21 and 22). The Gem Beach Channel on Catawba Penninsula was the most heavily used boat departure site. The shore angler facilities most utilized are in the Lorain-Cleveland area (Figure 23). 55 percent of the Lake Erie angler hours are from shore and 45 percent from boats (Table 46). Fishing for walleye during the 1975-1977 study period increased, dividing the summer into an early summer walleye season and a late summer perch season.

The total estimated Ohio Lake Erie fish harvest in 1978 was 16.7 million pounds. The commercial industry harvested 9.1 million pounds and the sport anglers 7.6 million pounds (Ohio Department of Natural Resources, 1979). In 1978, the sport

anglers harvested 46 percent of the four major species taken by both the commercial fishermen and sport anglers. Table 47 compares Ohio's sport and commercial harvests from 1975 - 1977. From 1975-1977, the percent of sport harvest by species was: perch 46 to 55 percent; white bass 27 to 39 percent; drum 41 to 64 percent; channel catfish 39 to 49 percent.

Commercial Fishery

Recently, Ohio commercial fishermen in Lake Erie have annually harvested about 8 million pounds of fish. Baldwin and Saalfeld (1962) documented commercial fish production in the Great Lakes from 1876-1960 and the Ohio Division of Wildlife (1956) summarized Ohio Lake Erie commercial fish catch from 1885-1955. Since 1965, the Ohio Division of Wildlife, in annual editions of Publication 200, summarized the Ohio Lake Erie commercial fish landings. The U. S. Bureau of Commercial Fisheries provided the earliest commercial catch data for Lake Erie in 1885 and 1890. The commercial harvest was recorded on an annual basis starting in 1914. Standardized total catch records were not kept until 1935.

Figure 24 shows total Ohio commercial production in 1885, 1890 and from 1914 to 1976. The largest recorded catch was in 1890 and comprised mostly of lake herring. Total harvest declined from 45 million pounds of fish in 1890 to 14.5 million pounds in 1924. For the next six years, total harvest never reached 17 million pounds. A rise to 23.5 million pounds in 1930 (due to an increase in blue pike catch) was followed by total harvest mostly above 20 million pounds until 1957. Only in the years 1933, 1940, 1941, 1947 and 1951 did total millions of pounds of harvest fall into the upper teens. Landings have steadily dropped since 1957 to the recent levels of 7 to 8 million pounds.

The species currently harvested commercially are yellow perch, white bass, channel catfish, freshwater drum and carp. Hartley and Van Vooren (1977), in a review of reported Ohio commercial landings by species, listed 20 distinct species, one subspecies and six colloquial names for various groups of fish which probably included at least 12 additional species. Muskellunge and lake trout are not officially listed in Ohio commercial landings, but were mentioned in descriptions of catches during the 1800's.

Production of yellow perch, white bass, channel catfish, freshwater drum and carp increased during the 1950's while blue pike, sauger and walleye production declined; carp landings have remained at a high level and white bass catches have greatly fluctuated. Total commercial landings from Ohio waters of Lake Erie 1976-1978 are shown in Tables 48, 49, and 50.

Ohio Division of Wildlife action plans (1975) and the Great Lakes Basin Commission's 1975 fish appendix made some forecasts concerning future regulations and trends for Lake Erie fish species and total harvest. The increased utilization of abundant low-value species (carp, freshwater drum, gizzard shad) is

of prime concern and is the subject of many studies (Krzeczkowski, 1970; Van Meter, 1973; Hauck, 1975; Stone, 1975; Morgan, 1976; U. S. Fish and Wildlife Service, 1975, 1976). Present studies are attempting to develop new fish products, improve processing methods, improve shelf life of freshwater drum and improve live-hauling techniques for drum. Scholl (1975) predicted that an increase in consumer demand for freshwater drum could increase Ohio commercial harvest from the current 6 million pounds to 13 million pounds annually.

Increases in the minimum size limit for yellow perch and white bass have been recommended (Van Vooren et al., 1977). Increased minimum size limits can result in long term increases in pounds of fish landed after initial short term decreases in commercial harvest. Commercial harvest by quota is forecasted for yellow perch, white bass and channel catfish by the mid-1980's (Ohio Division of Wildlife, 1975).

Amphibians and Reptiles

The study area falls within the range of 19 species of amphibians and 22 species of reptiles (Nixon et al.). The amphibian list includes one mudpuppy, one newt, seven salamanders, two toads, and eight frogs. The reptile list includes one skink, seven turtles, and 14 snakes. Due to the isolation and size of the islands, only ten species of amphibians and 14 species of reptiles are listed as occurring on the Lake Erie Islands by Cooper and Herdendorf (1977). Table 51 lists the amphibians and reptiles of the southwestern Lake Erie along with their respective habitat preferences.

Among the reptiles occurring along the southwestern Lake Erie shore and islands, a few species are noteworthy of special mention. Ohio's population of Blanding's turtle is limited to the northern counties along Lake Erie, where it inhabits the marshy shorelines, inland streams, and wet meadows. The Lake Erie water snake is a subspecies of the widely-distributed northern water snake. The Lake Erie subspecies is similar to its relative, except that the dark pattern of crossbands is very pale or completely lacking. These snakes are limited to the islands of Lake Erie near Put-in-Bay and are abundant on the undeveloped islands. The eastern fox snake has a distribution limited to the Lake Erie islands and the southwestern shore of Lake Erie west of Sandusky.

Birds

The southwestern Lake Erie area has a diverse avifauna. Bird lists are found in numerous publications. The bird lists contained in Campbell (1940), Langlois and Langlois (1964), Trautman and Trautman (1968), and Cooper and Herdendorf (1977) are often cited in Lake Erie literature.

A list of 267 birds for the Ottawa National Wildlife Refuge Complex is fairly representative of the birds which may be found in the southwestern Lake Erie area. Table 52 reproduces this bird list for Ottawa National Wildlife Refuge Complex. An additional 20 species of birds are listed as accidentally occurring in the area.

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Of the 267 species, approximately 33 species, or 12.4% can be considered permanent residents. Approximately 85 additional species, or 31%, nest but do not winter in the area. The remaining 149 species, or 55.8%, are either spring and fall migrants or winter visitors. Approximately 165 of the 267 species are typical of upland habitats. The remaining 102 species are generally found in open water, shoreline, marsh, or riverine situations.

When most of northwestern Ohio was unsettled, the dominant birds must have been those of forest and marsh—the dominant habitats. With the clearing of forests, these species declined in numbers, but were replaced with an increase in those species which could live in second-growth woods. Cultivation and agricultural practices created habitat for open field and meadow species. Finally, species which could adapt to man-made structures and environments also increased. On the other hand, many shorebirds, rails, ducks, and game birds declined as a result of the draining of marshes and overhunting. The 1900's experienced a continuation of the decline of waterfowl and shorebirds until laws and stringent measures were implemented for their protection. Droughts in 1930 and 1935 further depressed waterfowl numbers. Certain songbird species have also declined due to the elimination of their natural habitats. More recently, pesticides and other environmental contaminants have been a factor in the decline of raptor and piscivorous bird populations. (Campbell, 1940; Trautman, 1977)

Endangered Birds

Seven species of birds are on the state endangered species list. Table 53 provides a list of state endangered bird species which have been known to occur in the southwestern Lake Erie area.

The American peregrine falcon, sharp-shinned hawk, and Kirtland's warbler are migrants through Ohio. The Ottawa NWR Complex records 90 use days in 1976 for the peregrine falcon, 2,850 use days for sharp-shinned hawk in 1977, and sighting of one Kirtland's warbler in May of 1976. Since all possible sources of sightings were not contacted, other sightings may have been recorded.

The king rail and bald eagle are known to breed within the study area. The Ohio-Lake Erie bald eagle population has been closely followed in recent years. Information on the king rail, however, is scarce.

The bald eagle once nested throughout the Great Lakes region and wintered along major waterways in the southern portion of the Great Lakes states. Populations have declined as a result of losses of habitat and various other activities, including the use of toxic chemicals. In Ohio, a small resident population of bald eagles exists along the western shore of Lake Erie. This small population is "holding on" in an area of marginal habitat. Severe winters and storms have resulted in the destruction of nests and eagle losses. Habitat lost through the development of shoreline areas and human disturbances are other major factors in the eagles' decline.

Transient bald eagles are occasionally found along Lake Erie during spring and fall migration. Campbell (1940) noted pronounced migration movements from March 17 to April 16 and from August 31 to October 31. Trautman and Trautman (1968) noted migration movements from February to March and October to November. Trautman and Trautman added that there may be a late spring to early summer invasion of southern birds aside from these spring and fall movements. Staff members of Ottawa NWR Complex have noticed marked bald eagles which were traced to populations marked in Saskatchewan.

Eagles' nests have been found in the tops of tall trees within one mile of a major water body and fishery resource. Nests have been found on Ottawa NWR, Winous Point Marsh, Ottawa Shooting Club Marsh, Green Island, East Sister Island, West Sister Island, Kelleys Island, Rattlesnake Island and privately owned woodlots on the mainland.

Table 54 presents bald eagle nesting data for Ohio from 1973 to 1979. Not represented in the table is one eaglet which was released along the Lake Erie shore after fledging in captivity in the summer of 1979.

The breeding ecology of the bald eagle is described by Herrick (1924 a, b, c, and 1933). The nesting cycle normally starts by mid-February but may be delayed until March if unfavorable conditions persist. One to three eggs are laid in early March with both parents incubating and caring for the young. Incubation lasts 34 to 35 days. By 12 weeks, usually late June to July, the young fledge. The young remain with the parents into the fall and may not become independent until late October or possibly later.

The king rail is generally seen only a few times during a season. Andrews (1973) presents a short literature search of what is known of the king rail's life history and ecology. Most of the past literature on the king rail is a result of studies in other states. The king rail appeared to prefer nesting along sedge borders of marshes. Water depth at nest sites ranged from 4 to 18 inches. There have been only a handful of known king rail sightings in any Lake Erie marsh within the last several years—the capture of downy young with adults in 1971 (Andrews, 1973), the notation of 30 use days by king rail in Ottawa NWR Complex in 1977 (Department of the Interior, U.S. FWS, Ottawa National Wildlife Refuge Complex, 1977), and one recent sighting at Magee Marsh (Brackney, pers. comm.).

The upland sandpiper was a numerous migrant through the area until the 1930's. Nesting and migrating populations of upland sandpiper has significantly decreased over the past 60 years. (Trautman and Trautman 1968; Trautman 1977). Ottawa NWR Complex notes 60 use days for upland sandpiper in 1977.

The common tern is a colonial nesting species and normally nests in the Great Lakes region during late May through mid-June. The common tern may attempt to renest if initial efforts are washed out. Scharf (1978) observed colonies of common terns in 1976 and 1977 on a man-made island known as Toledo Harbor Dike. Scharf

estimated 77 nests on the island in 1976 and 283 nests on the island in 1977. Common terns have been noted historically as colonizers of sites in early stages of plant succession (Palmer, 1941). Bare gravelly, sandy soils with sparse vegetation have been documented as the preferred nesting habitat of common terns (Palmer, 1941). Observations by Scharf (1979) show that common tern activities have little effect on vegetative succession. Therefore, as the vegetation naturally grows to taller heights and woody species replace herbaceous ones, common terns are forced out. Perennially bare and sparsely vegetated areas have been occupied by the larger colonies of common terns on the Great Lakes (Trautman, 1977; Scharf, 1979).

Evidently, common terns existed in greater numbers in the past than they do presently. The decrease in nesting numbers and near extirpation of the common tern was caused primarily by the herring gull which invaded the western Lake Erie region about 1945 and has since occupied most of the former nesting territory of this tern. Common tern nesting sites have also been known to have been invaded by ring-billed gulls and inundated by high water. Scarce habitat has sometimes forced common terns to nest on sandbars cut off by high water levels. (Trautman,1977; Scharf, 1979).

The preceeding comments on endangered species do not fulfill the requirements of Section 7 of the Endangered Species Act of 1973, as amended, which requires the Federal Agency which authorizes, funds, or carries out any action, to request of the Secretary information whether Federal listed or proposed species are likely to be found in the project area. This can be done by writing to the Regional Director, U. S. Fish and Wildlife Service, Federal Building, Fort Snelling, Twin Cities, Minnesota 55111.

Waterfowl

The primary waterfowl nesting species found along southwestern Lake Erie of the dabblers, or puddle ducks, are the wood duck, mallard, black duck, and blue-winged teal.

Andrews (1952) offers an excellent short history of early waterfowl abundance records in Ohio up to 1952. In summary, 1880 and 1930 summer waterfowl records for Winous Point showed that there was a relative scarcity of nesting ducks in these years. At least a few mallards, black ducks, wood ducks, and blue-winged teal probably nested at Winous Point in both 1930 and 1932, and perhaps in 1880. In 1932, Trautman found black ducks to be the most common nesting duck of the southwest Lake Erie regions, followed closely by the mallard. A fair number of wood ducks, about as many blue-winged teal, and an occassional pintail or shoveller could be expected to nest in the area also. By 1951, Andrews noted considerably more nesting mallards than black ducks at several Lake Erie marshes while only black ducks nested on the Lake Erie islands. Despite the apparent shift in abundance from black duck to mallard, Campbell indicated to Andrews in a personal conversation that the most spectacular increase in abundance has been observed in wood duck populations.

Current data on waterfowl breeding populations and production along southwestern Lake Erie appears to be sketchy. Raw data and unpublished information on waterfowl breeding populations and production probably exist among the records and observations of various researchers and waterfowl management units. To date, this material has been unattainable and an updated picture of present waterfowl production is needed.

The best available information on southwestern Lake Erie waterfowl comes from research done in the 1950's and 1960's. Table 55 presents waterfowl territorial pairs which were observed on Magee Marsh from 1953 to 1964 by Bednarik and Thomson (1965). Table 56 presents estimates of breeding populations of waterfowl in selectively chosen marshes by various researchers. Table 57 presents estimates of waterfowl nesting densities as computed from observations in various Lake Erie marshes by various researchers. Table 58 presents a comparison of waterfowl breeding population data and estimates for 1951 and 1952 in two different study areas by two different researchers. Tables 59 and 60 present 1951 and 1952 waterfowl nesting success and brood data for Winous Point.

As demonstrated in Table 58, care must be taken in using this data to make a generalization regarding the Lake Erie marsh areas. Obviously, marsh quality is not uniform and the 40-acres which can support four breeding pairs in one area can only support one pair in another. Also, since 1964, significant changes in marsh habitat make the use of this information difficult in attempting any estimate of current populations. On one hand, high lake levels and the significant reduction of wetland acreages in the northwestern Ohio area would suggest a reduction of breeding waterfowl populations. On the other hand, recent repair of many dike systems and management practices on various waterfowl management areas suggest the possible improvement of habitat for waterfowl production. Until current data is collected, compiled, and analyzed, up-to-date waterfowl breeding population information and production estimates for southwestern Lake Erie will be lacking.

Early nest establishment is generally recognized as a factor contributing to nesting success; however, Handley (1954) noted that renesting attempts by waterfowl have been more successful due to the greater amount of vegetative growth. Regardless, predation remains a significant factor contributing to nest losses. In Andrews' (1952) study, 66% of the waterfowl nests established were destroyed by predators. An additional 22% of the waterfowl nests established were destroyed due to other causes. Waterfowl egg predators are numerous, with raccoon, skunk, opossum, fox, mink, weasel, and fox snake appearing to be the major nest predators along Lake Erie (Bailey, 1968; Urban, 1968). Nests along dikes are particularly vulnerable to predation while nests atop muskrat homes have been the least disturbed (Andrews, 1952). Flooding and nest desertion have also contributed to nest losses. Several researchers use 80% as a rough estimate of "percent waterfowl nest lost" in making waterfowl production estimates along Lake Erie (Handley, 1954; Bednarik, 1963; Kauffeld, 1979).

The wood duck nests in natural cavities and in stumps of trees. Stewart (1957) found that the average cavity diameter was 10 inches and entrances averaged 6 inches in diameter for 58 occupied natural cavities studied in Ohio. Cavity bearing trees in Ohio are generally sycamore, beech, and elm trees. Gilmer et al. (1978) in a study of 31 cavities used by wood duck in Minnesota found that nests were found closer to water areas and forest canopy openings than randomly selected cavity bearing trees. In addition to the nest site itself, the nesting area should include open water for courtship, loafing, male displaying, and sufficient food resources within one mile of the nest site.

Wood duck production in Ohio has been enhanced by Ohio Department of Natural Resources' wood duck nesting box program. In 1979, none of the 34 boxes in Lucas County were utilized, whereas 39 of the 137 boxes (28%) in Ottawa County were utilized. Approximately 54% of the boxes utilized in Ottawa County succeeded in hatching 199 eggs. Generally, the boxes are 30% successful in being utilized and low use figures for Lucas County are due to lack of maintenance of boxes or poor box site locations (J. Weeks, pers. comm.).

Hens will lead their broods to water the first day after hatching. Wood duck broods spend several weeks in and close to ponds or small streams gradually making their way to larger water bodies. These areas must have sufficient cover in the form of bank vegetation or emergent aquatic vegetation. Around the first of October, wood ducks begin to congregate in creeks and along streams. Principal habitats in Ohio at this time are buttonbush swamps or flooded timber lands.

The Bureau of Outdoor Recreation, ODNR, reports 0.5 wood duck broods per mile for the Maumee River from 1952 to 1971. Wood duck habitat along the Maumee River is considered good but not outstanding. ODNR reports a mean of 0.08 wood duck broods per mile for the Sandusky River from 1974 to 1977. Similar information for other streams in the study area is lacking.

Wood duck migratory routes to and from Ohio are difficult to delineate. No well defined migratory corridors are known. Presumably, most of Ohio's birds are produced here in Ohio and travel southward through various river courses to winter in coastal swamps (Kauffeld, 1979).

The major Ohio dabbler duck nesting species besides the wood duck are the mallard, black duck, and blue-winged teal. Recent breeding population estimates along southwest Lake Erie for these species are lacking. In a study by Andrews (1952), mallards and black ducks contributed up to 70% of 1951 to 1952 breeding waterfowl at Winous Point marsh. Mallard pair densities at Magee Marsh averaged 21 pairs per square mile from 1960 to 1964, black duck densities averaged 5.6 pairs per square mile, and blue-winged teal averaged 30.1 pairs per square mile (Bednarik and Thomson, 1965).

The loss of wetlands has contributed to the loss of potential nesting habitat. On managed marshes, areas that are drawn down to provide feeding areas for waterfowl are unattractive to breeding pairs. Mallard, black duck, and blue-winged

teal nesting habitat in Ohio is primarily associated with Type 3 (inland shallow fresh marsh), Type 4 (inland deep fresh marsh), and Type 5 (inland open fresh water) wetlands as defined in *Circular 39, Wetlands of the United States* (Shaw and Fredine, 1971; Kauffeld, 1979).

Mallards and black ducks begin to establish nests in April through May. Blue-winged teal begin nesting about one month later than mallards and black ducks. Average clutch size is 6.03 eggs for mallard, and 8.86 eggs for teal. Nests are located along dikes, atop muskrat homes, and along marsh and cattail edges. Blue joint grass, sedge, goldenrod, barnyard grass and cattail have been used as nesting cover. Mallard and black duck have located nests closer to water than blue-winged teal. Mallard and black duck nests were found within 9 yards of water while blue-winged teal nests were found as far as 50 to 70 yards from water. In general, mallards exhibit a wider range of nest site locations; mallard nests have been found in field and in tree cavities. Mallard nests comprised 32.3% of total nests found on Magee Marsh in 1907; blue-winged teal nests comprised 65.5% of total nests found in the same area (Bednarik, 1967). As noted in Table 60, Andrews (1952) observed that mallard and black duck nests comprised 85% and blue-winged teal nests comprised 8% of total nests found on Winous Point in 1951 and 1952. Bailey (1968) noted nest densities of 1.9 waterfowl nests per acre in 1967 and 2.2 waterfowl nests per acre in 1968.

Currently, diving duck production in Ohio is nearly non-existant. Redheads have been recorded as nesting in the Lake Erie marshes. Hooded mergansers are reported using wood duck boxes in some areas. In earlier times, abundant aquatic vegetation attracted canvasback and redhead ducks. However, increased suspended sediment loads from rivers, streams and canals, dredging operations, and the introduction of carp eliminated many areas of aquatic vegetation. Consequently, birds dependent on aquatic vegetation for food have also declined.

A Canada goose (Branta canadensis maxima) population has been established at Ottawa National Wildlife Refuge through a cooperative agreement between the Ohio Department of Natural Resources and the U. S. Fish and Wildlife Service. The goose population, now numbering approximately 3,500 birds (J. Weeks, pers. comm.), was started in 1967 by wing clipping certain individuals for 5 years. The young of the artifically maintained resident population became imprinted to the surrounding area and formed the resident population which can be seen along the marshes of Lake Erie today.

Canada geese begin nesting as early as March; however, peak nest initiation is in early April. Average clutch sizes are five eggs per nest. Hatching begins about the third week in April for northern Ohio with peak hatching about mid-May. According to ODNR personnel, nesting success for Canada geese is attributed to the use of nesting tubs. Apparently ground nests are initiated later and are subject to higher predation rates than tub nests. The nest success rate for 1974 was 68%. Approximately 900 young were produced by the local flock in 1974, 1,400 young in 1978, and 1,200 young in 1979. The increased production of Canada geese has resulted in a population increase from approximately 3,000 birds in 1974 to approximately 3,500 birds in 1979.

Shorebirds

Shifts in shorebird populations have been noticed over the past 60 years. Species such as the short-billed dowitcher and stilt sandpiper have been observed with increasing frequency and in greater numbers than in the past, while declines have been noted in species such as the pectoral sandpiper, solitary sandpiper, and upland sandpiper. The exposed shore areas and mudflats where many shorebirds feed have become limited. High lake levels, shore erosion protection structures, and development have reduced the amount of available habitat. Changes in the benthic community and in other food resource bases may also be factors contributing to the declines. Trautman (1977) noted that before 1930, the piping plover annually nested on the larger beaches along the south shore of Lake Erie. In more recent years only an occasional nesting pair has been reported. Today their former nesting habitat in Ohio is occupied by homes, swimming beaches, and picnic areas.

The Ottawa NWR staff noted that more mudflat areas in 1976 brought in more accidental and rare shorebirds. The Ottawa NWR staff noted peak numbers of shorebirds in May of 1977 and in the summer of 1978. Approximately 7,000 birds were recorded in the summer of 1978. Trautman (pers. comm.) has noticed as many as 3,000 birds using the mudflats along Lake Erie at one time.

Marshbirds

The Lake Erie marshes support populations of marsh birds including coots, gallinules, marsh wrens, rails, and bitterns. Trautman (1977) has noted declines in the least bittern, American bittern, king rail, Virginia rail, and common gallinule populations as a result of the destruction or decrease in the amount of acceptable habitat. Few studies are available on Lake Erie populations of marsh birds. The best available information on Lake Erie marsh bird populations came from graduate student theses of the Ohio State University. For example, Andrews (1973) studied the sora, Virginia, and king rails at Winous Point Marsh. Brackney (1979) studied the common gallinule populations in several Lake Erie marshes.

Andrews (1973) did not make estimates of population numbers but indicated that nesting populations of all three species appeared small. He observed the highest nest density to be 1.5 nests per acre. The greatest nesting success recorded by Andrews for either Virginia rail or sora rail at Winous Point was 50% of the known active nests. Nesting success, considering all nests found, was 11%. In general, Andrews' study indicates that sora rails appear to vary their habits according to habitat availability more than king rails. Virginia and king rails appeared to be more selective in their food preferences and nesting sites.

A decline in the Lake Erie population of common gallinule was noted in the 1960's. Prior to the 1900's, common gallinules for Brackney (1979) estimated 1198 $\pm$ 520 pairs of common gallinules for southwestern Lake Erie marshes (Table 61). Brackney found common gallinules in 1,774 acres, or 14% of the 12,820 acres of Lake Erie marshes he studied. Pair densities ranged from 1.8 $\pm$ 1.0 pairs per acre at Cedar Point marsh to 11.4 $\pm$ 2.0 pairs per acre at Navarre Marsh. Nesting success was approximately 66%.

Upland Birds

Quantitative information on the populations of various upland birds is generally not available. Some information on the harvest of certain game birds is available from the Ohio Department of Natural Resources. While this information may be used to obtain a rough idea of game populations in certain areas of the state, the information generally spans too great an area to give any clear indication as to the dynamics of various bird populations along the Lake Erie shore and on the islands.

Changes in the composition of upland bird species have corresponded to habitat changes. The elimination of specific insects and utilization of sprays for the control of Dutch elm disease have resulted in declines of species such as wood pewee, red-eyed vireo, warbling vireo, and yellow warbler. Declines have also been noted in catbird, brown thrasher, house wren, song sparrow, downy woodpecker, nighthawk, and chimney swift. Dominant types today are American robin, blue jay, cardinal, flicker, mourning dove, common grackle, starling, house sparrow, and red-winged blackbird. The red-winged blackbird originally nested primarily in swamps, marshes, or other wet depressions. After 1920, the red-winged blackbird began increasingly to nest in fields which were planted in grains and forage crops, on dry hillsides, and other mesic to xeric situations. As a result of adapting to another abundant habitat type, the species greatly increased in numbers despite the draining of its former swamp nesting habitat (Campbell, 1968; Pinsak and Meyer, 1976; Trautman, 1977).

Several exotic species were introduced in the early 1900's. Among these were gray partridge and ring-necked pheasant. Gray partridge, a grassland species, is uncommon in the Maumee Basin (Ohio Department of Natural Resources, Bureau of Outdoor Recreation, 1974). Ring-necked pheasant was introduced along the Lake Erie shore counties and on the Bass Islands. Ring-necked pheasant habitat is considered to be of medium quality along the southwestern lake shore. Trautman (1977) noted that modern clean farming practices have resulted in the decline of pheasant populations. The removal of brushy fence rows, weedy fields, winter cover, and crop waste have left little habitat and food for the ring-necked pheasant. The Ottawa NWR Complex staff estimated the ring-necked pheasant population utilizing refuge areas to be approximately 350 birds with 100 produced in 1975 and approximately 100 birds contributing to 26,000 use days on the refuge in 1977. The pheasant population on South Bass Island has multiplied to where it has become a nuisance to farmers and grape growers (Cooper and Herdendorf, 1977).

Bobwhite populations have declined since 1800. Bobwhite populations are currently very low. Like the pheasant, quail habitat quality is marginal due to clean farming practices; the lack of sufficient food and cover has resulted in an increase in bobwhite mortality during adverse weather. During the severe winters of 1976 and 1977, bobwhite numbers were drastically reduced throughout Ohio (Trautman, 1977).

Woodcock populations along southwestern Lake Erie are also low. Woodcock habitat within the study area is limited and marginal in quality (Trautman, pers. comm.).

Colonial Nesting Birds

Several species of colonial nesting birds nest along the southwestern Lake Erie area and the Lake Erie islands. Table 62 presents a list of colonial nesting birds which may be found in the study area.

The colonial nesting bird populations of Lake Erie have been studied in detail by Scharf (1971 and 1979) and various students at Ohio and Michigan Universities. Tables 63, 64, and 65 present a summary of some of the available information. Table 63 presents an estimate of numbers of breeding pairs of Lake Erie colonial nesting birds during 1976 and 1977. The information presented in Table 63 also includes population estimates from the Lake St. Clair and Detroit River areas. Table 64 presents a more detailed breakdown of nest numbers, or breeding pairs, for the Ohio-Lake Erie area only. Selected figures from Tables 63 and 64 are presented again in Table 65. Table 65 indicates that the southwestern Lake Erie area supports close to 50% of Lake Erie's total population of colonial nesting birds.

Great blue heron and great egret nest in tall living or dead deciduous trees. The particular tree species is not considered as important a factor in nest site location as is the tree's growth form. Herons may change the location of their nesting colony to take advantage of available trees.

Nest sites are most frequently found near marshland feeding areas. Major feeding points for the West Sister colony of great blue heron and great egret range from Cedar Point near Toledo to the Erie marshes at the Michigan border. Great blue heron and great egret colonies near Sandusky feed along Muddy Creek, the Sandusky River, Metzger Marsh, Magee Marsh, and Darby Marsh. Accounts of several thousand herons and egrets feeding in these areas indicate the importance of these areas. Many of these areas are under protection of governmental agencies or private clubs, but others are privately owned and their future is uncertain.

Open areas near the nesting site are important as staging areas where the young birds learn to fly without the harrassment and potential injury caused by marauding herring gulls. In some cases, the feces whitewash is strong enough to kill understory vegetation under nest trees; however, occasionally it has the opposite effect and stimulates vegetative growth as is the case on West Sister Island.

Great blue heron and great egret populations are presently considered stable. The Winous Point and West Sister colonies of great blue heron and great egret form the major portion of the Great Lakes population. In 1976, the great egret in the Great Lakes region was limited in range to the west end of Lake Erie including the West Sister Island colony and two colonies in the Detroit River and Lake St. Clair (Scharf, 1979).

Black-crowned night heron prefer to nest and to roost in brushy areas. On West Sister Island, black-crowned night heron make use of small plum and hackberry trees. Black-crowned night heron habitat is threatened with reduction by vegetative succession, by erosion and flooding of brushy areas by high water, and by dike and levee construction.

Trautman (1977) noted that huge colonies of black-crowned night heron occurred throughout the 1940's and early 1950's on Middle Bass and North Bass Islands. Since then, these colonies have been greatly decimated. The cause has been attributed to the widespread, recent use of DDT and other insecticides or poisons which affect the breeding cycle of piscivorous birds.

The cattle egret is a species which is expanding its range throughout North America. Cattle egret nesting was not recorded in the southwestern Lake Erie area until recently when cattle egret nests were noted on West Sister Island. First observations of nesting cattle egrets were made in 1978 when approximately 20 nests were recorded. An estimated 13 nests were noted in 1979.

Herring gulls utilize two substrate types along southwestern Lake Erie for nesting habitat. One substrate is bare rock (granite, sandstone, or limestone) as found in parts of the Bass Islands of Lake Erie. The second type of habitat is heavy herbaceous cover. An example of this habitat type can be found on the Sandusky Turning Point, a detached breakwater in Sandusky Bay, the only man-made herring gull site in the U. S. waters of the Great Lakes and not within the study area.

Herring gull nesting efforts were very successful during 1976. Extremely early nesting by the majority of the population was noted in 1976. Hatching occurred in the second and third weeks of May at the Sandusky Turning Point colony of Lake Erie. Normally, hatching begins in the second week of May and peaks in the third and fourth weeks of May at 45° N. latitude (Scharf, 1979).

Herring gull populations appear to have stabilized at lower levels than previous years due to environmental contaminants according to Scharf (1979). Scharf noted that many Great Lakes herring gull nesting sites have been invaded by ring-billed gulls. However, this is not apparent among Lake Erie colonial nesting sites, and many herring gull sites throughout the Great Lakes have not been invaded by ring-billed gulls. Herring gull populations at Rattlesnake, Starve, and Green Islands have not been invaded by ring-billed gulls as of 1977.

Ring-billed gulls appeared most successful when nesting on substrates of heavy silt and high clay content or soils with high clay and organic content. The heavier soils support the type of cover vegetation which ring-billed gulls prefer. The vegetative cover separates the territories and permits greater nesting densities. The invasion of herring gull nesting sites and common tern nesting sites by ring-billed gull has been noted previously. The more aggressive, earlier nesting ring-billed gull excludes other species from using preferential nest sites.

Migration and Wintering Areas

The importance of the western basin of Lake Erie as a migrational area for birds has long been recognized by ornithologists. The western shore of Lake Erie lies within the path of several important migration routes. Campbell (1940) and Pinsak and Meyer (1976) describe two major continental migration lanes through Lucas and Ottawa Counties. Branches of both the Atlantic and Mississippi flyways pass over the western end of Lake Erie as illustrated by two species—whistling swan and snow goose. Whistling swans follow the Atlantic flyway, passing over Lucas and Ottawa Counties while migrating between their wintering grounds at Chesapeake Bay and their breeding grounds in northwestern Canada and Alaska. Snow and blue geese migrate the Mississippi flyway, passing over Lucas and Ottawa Counties while migrating from Hudson Bay to the Mississippi River Delta. Bellrose (1976) showed the existence of a heavily used waterfowl migration corridor originating from major corridors down the Great Plains and Missouri-Mississippi River valleys eastward across the Great Lakes area to the Atlantic coast.

Three local and well-defined migration routes pass through Lucas and Ottawa Counties. One route follows the islands across Lake Erie from Catawba Island, Ohio to Pelee Point, Ontario. This migration route is extensively utilized during spring and fall by passerines. The second local migration route is along the shoreline, crossing Maumee Bay near Cedar Point National Wildlife Refuge, and continuing along the west shore to the narrows south of Detroit, Michigan. Campbell (1940) describes the slight variations of this migration route by various bird species. Some of this shoreline route's frequent users in spring and fall are crows, geese, hawks, woodpeckers, swallows, and blackbirds. Snow buntings, lapland longspurs, horned larks, and water pipits are regular fall users of this route. A third migration route follows the Maumee River. This route is used by swallows in the spring and fall. Franklin's gulls and Forster's terns move into Lucas County from the west by this route as fall approaches.

The number of birds utilizing the various migration routes through southwestern Lake Erie and northwestern Ohio is difficult to estimate. Most of the quantitative information on migration through Ohio concerns waterfowl. Bellrose (1976) presents migration corridors for various species of waterfowl along with estimates on the traffic for each corridor. However, the direct use of this information tends to overestimate the waterfowl use of the southwestern Lake Erie area. Table 66 presents some estimates of waterfowl numbers migrating through West Harbor. Ottawa County, Ohio. Table 67 presents some 1974 data from observations of migrating waterfowl by Karl Bednarik of Crane Creek Wildlife Experiment Station.

Migration is a regular, annually induced movement, modified by local weather conditions. Despite the complex combination of factors which stimulate each species to migrate, the arrival and departure of birds year to year exhibits an impressive degree of regularity. Campbell (1940) has compiled a table of migration

arrival [illegible] dates in Lucas County for 272 spec[illegible] of birds based on observ[illegible] a 13-year period. In general, the migration [illegible] of small passeri[illegible] Lake Erie are observed each spring in May and each fall from August [illegible]er. For waterfowl, spring migration movements along Lake Erie are obs[illegible] in spring from March to May and later in fall from September to N[illegible] Trautman and Trautman (1968) present average arrival and depar[illegible] Ohio for 285 species of birds. Peak populations dat[illegible]s for major dabbling [illegible] species are presented in Table 68.

Quan[illegible]tes of migratory bird use in the southwestern Lake Erie area is not as c[illegible] as the arrival and departure dates but may vary considerably from year [illegible] However, two primarily local factors appear to determine the migrat[illegible] Ohio by waterfowl.

One [illegible] spring weather conditions on the breeding grounds north and west o[illegible] weather may delay nesting on breeding grounds or allow early nesting. [illegible]rtantly for waterfowl, spring and winter precipitation are primari[illegible] for water level conditions at breeding initiation and the durati[illegible] water in prairie potholes and other wetlands areas. In general [illegible]er levels are adequate and potential breeding and brooding groun[illegible] until July, more waterfowl will be produced than in drier years. A hig[illegible] waterfowl results in more birds migrating south.

The se[illegible] factor is fall and early winter weather in Ohio. Generally, Lake Erie [illegible] over in late November and early December. As these marshes free[illegible] move south into the central and southern portions of the state. Howev[illegible] which severe cold snaps occur throughout the state, as in 1977, [illegible] the state's waters froze over at the same time, most of the south[illegible] portions of the state received little or no use as birds overflew thes[illegible]

The [illegible] Ohio by small passerines and by other migratory species can be ex[illegible] similar patterns given slight adjustments to their respective life [illegible]

The [illegible] shore of Lake Erie is a wintering area for certain bird species. Campbell [illegible]) noted that the number of wintering bird species fluctuated in number [illegible] composition from year to year. In very cold winters, Campbell noted more win[illegible] [illegible]itors and less half-hardy species (summer residents and fall migrants[illegible] in warmer winters, he noted more half-hardy species and less winter v[illegible]stmas bird counts indicate the presence of 56 species in 1975, 52 spe[illegible], and 51 species in 1977.

Certain [illegible] have particular attraction to overwintering birds. Open water areas which [illegible] freeze attract fish and waterfowl. These areas may exist in associati[illegible] falls and rapids along a stream or thermal outfalls into Lake Erie.

A map of some intakes and outfall points on Lake Erie may be found in the Great Lakes Framework Study (Great Lakes Basin Commission, 1975b). Areas of food availability such as fall crop fields and unharvested soybeans near the study area will receive winter use by waterfowl.

Scharf (1971) summarized the "critical nesting and migrational areas" of the Great Lakes within the United States. Table 69 presents a modified version of the critical areas that Scharf listed for Lucas and Ottawa Counties. "Critical areas" as defined by Scharf are those that serve as concentration points for nesting or migrating species. West Sister Island and North Bass Island are considered "critical areas" for the great blue heron, black-crowned night heron, and great egret. Darby Marsh is considered a "critical nesting area" for black tern in Scharf's original table. However, black tern is not a colonial nester. Since the quality of any given marsh may change from year to year, black terns would make use of any marsh or marshes which best satisfy their nesting preferences within a given year. Ballast Island and Starve Island (near South Bass Island) were cited as "critical nesting areas" for herring gulls and ring-billed gulls. Ottawa NWR, Magee Marsh, Ottawa Shooting Club Marsh, Winous Point Shooting Club Marsh, Green Island, and Cedar Point NWR were listed by Scharf as "critical nesting areas" for the bald eagle.

In addition to the areas listed by Scharf, Maumee Bay and the lower end of the Maumee River have been noted in literature as resting areas for many varieties of waterfowl and feeding areas for diving ducks, grebes, gulls, and terns (Campbell, 1940; Pinsak and Meyer, 1976).

Mammals

Forty-two species of mammals have ranges which fall within the study area. Table 70 lists mammals occurring in the study area and their habitat preferences. The species list includes one marsupial, five insectivores, nine bats, nine carnivores, sixteen rodents, one lagomorph, and one ungulate. All but two species, the Norway rat and house mouse, are endemic to North America. The species diversity of the islands is understandably low considering their isolation from the mainland and the small area available on any particular island. Only 13 species have been recorded as being permanent island residents, and these are all small mammals.

As with birds, the mammalian fauna changed with the alteration of habitat. Certain species, such as opossum, eastern mole, deer mouse, and cottontail, expanded their ranges as a result of clearing land and creation of an open type habitat. Other species such as the gray squirrel, a woodland species, have more restricted ranges than in the past. Man also has had an effect on certain mammal species through hunting, trapping, and various agricultural activities.

Quantitative information on local mammal populations appear to be lacking. Bailey (1968) conducted a study in 1967 on waterfowl nest predators in Magee Marsh and calculated population densities and numbers for several mammal species. Table 71

presents a summary of his results. Urban (1968) found higher densities of raccoons on Winous Point in 1967 than Bailey found the same year on Magee Marsh. Urban estimated densities ranging from 37.1 to 54.1 raccoons per sqauare mile.

The muskrat is a furbearer which is trapped in many of the marshes along Lake Erie. From the 1939-1940 to 1950-1951 trapping seasons, approximately 96,900 muskrats were trapped on Magee Marsh. Trapping success at Magee Marsh has been lower in recent years due to water drawdown practices. The Ottawa NWR staff noted that in 1974 muskrat populations appeared to be decreasing as a result of selective trapping. The muskrat population estimate for the Ottawa NWR Complex in 1977 was 12,000 animals (US FWS, 1974 and 1977).

White-tailed deer populations along the Lake Erie shore appear to be low. The Ottawa NWR staff estimates the white-tailed deer population utilizing the refuge and neighboring areas to be approximately 30 individuals with approximately 8 young produced each year (US FWS, 1975 and 1976).

Recreational Use of Natural Areas

The southwestern Lake Erie area provides the public with numerous recreational activities throughout the year. The major recreational period is from Memorial Day in May to Labor Day in September. Peak use occurs in the months of July and August. In summer, various city, state, and federal areas offer fishing, camping, hiking, picnicking, powerboating, sailing, sightseeing, sunbathing, and swimming. In spring, fishing and sightseeing become major activities. In autumn, fishing, hunting, and sightseeing activities are predominant. In winter, ice fishing, ice skating, sledding, and snowmobiling are available.

A significant portion of Lake Erie shoreline within the study area is owned and administered by various government agencies (Tables 72 and 73). The City of Toledo has developed park recreational facilities along the shoreline. State and Federal agencies manage other public shoreline areas.

Ohio Department of Natural Resources, Division of Parks and Recreation, operate five state parks within the project area. These are East Harbor, Crane Creek, Kelleys Island, South Bass Island, and Catawba Island State Parks. Maumee Bay State Park is being developed near the City of Toledo. The state parks offer swimming, boating, hunting, fishing, camping, nature trails, and other recreational opportunities. Table 2 lists many of these areas, their acreages, and present use. Not listed are two state parks in Ottawa County, South Bass Island State Park and Catawba Island State Park. South Bass Island State Park is a 35-acre area which offers camping, swimming, picnicking, a marina, and passive recreation opportunities to the public. Catawba Island State Park is a 9-acre area which offers a boat launching site and picnic facilities. ODNR, Division of Wildlife, has established several wildlife areas in the coastal area, namely Metzger Marsh,

Magee Marsh, Little Portage, and Toussaint Wildlife Ar~~ Metzger and Magee Marshes are managed primarily for waterfowl, but also provide public hunting, fishing, and nature study opportunities similar to those offered at Little Portage and Toussaint Wildlife Areas.

The U. S. Department of Interior administers several areas along Lake Erie. Ottawa National Wildlife Refuge, which encompasses five units in the western basin, is managed for waterfowl (Table 2). Perry's Monument, commemorating Commodore Perry's victory in Lake Erie during the War of 1812, is a major tourist attraction on South Bass Island.

Table 74 provides some annual visitation and use figures for several management areas. Table 75 provides an analysis of visitor use at the Sportsmen's Migratory Bird Center at the Crane Creek Wildlife Experiment Station. If one may assume the data presented in Table 75 as typical of the Lake Erie area, it would appear that hunters and fishermen constitute a significant portic~ ~f the visitors along the southwestern Lake Erie area.

Recreational boating is a popular and significant use of the southwestern Lake Erie area. In 1972, approximately 27% (60,500 boats) of the 222, 000 boats registered in Ohio used Lake Erie as a principal water recreation location. Plate 6A is a map of special use areas along the Lake Erie shoreline. The hunting and boating use areas depicted were taken from Hartley and Van Vooren (1977).

Recreational fishing is a significant use activity for the southwestern Lake Erie area, the Bass Islands, and the major streams or rivers. Details regarding recreational fishing in the southwestern Lake Erie area have already been covered in the fisheries section of this report.

Hunting is a significant recreational activity along the southwestern Lake Erie area. About 63 percent of the statewide hunting pressure and 72 percent of the waterfowl harvest occur in the northern part of Ohio. About 22 percent of the total statewide waterfowl harvest occurs within the Lake Erie marsh areas of Lucas, Ottawa, Sandusky, and Erie Counties, excluding the high quality private duck clubs in this area. Table 74 provides some hunter use figures for several management areas.

Mallards, black ducks, wood ducks, and blue-winged teal make up approximately 7? percent of Ohio's annual harvest of more than 100,000 ducks. Mallards and black ducks are late migrants into Ohio and make up over half of the waterfowl reported during the hunter bag checks conducted in the Lake Erie marsh region. Wood ducks and blue-winged teals are early migrants and are less important to hunters along Lake Erie.

In addition to waterfowl, game and fur mammals offer additional hunting and trapping opportunities. Game and fur mammals present in the southwest Lake Erie area include muskrats, minks, raccoons, skunks, opossums, foxes, woodchucks,

cottontail rabbits, fox squirrels, and white-tailed deer. Trapping is particularly important in the Lake Erie marshes, and Ohio's high muskrat harvest is due principally to trapping along Lake Erie.

Hunting and trapping in the state and federally managed marshes and in some of the duck clubs are controlled and regulated activities. Muskrat trapping is a management tool used to reduce damage to dikes in these marsh areas. The number of hunters and trappers is regulated. Selection as to who is permitted to hunt or trap on public lands is generally made by lottery. Hunting in duck clubs is restricted to members. Landowners in areas neighboring the marshes may lease their lands to hunters.

SUMMARY

The southwestern Lake Erie study area is extremely rich in natural resources. Some of the most significant wetlands of Ohio and of the Lake Erie system are found in this area. The entire western basin and Bass Island region are well known for their fishery resource. The southwestern Lake Erie area is host to a diverse avifauna and provides breeding habitat for a few rare species such as the bald eagle, king rail, upland plover, and common tern. The colonial nesting birds found within the study area consitute a significant portion of Lake Erie's total colonial bird popuation. Finally, the southwestern Lake Erie area is a significant hunting, trapping, fishing and recreational area.

The natural resources of the southwestern Lake Erie area have been altered by man's influence. Land use changes have eliminated many areas of wildlife value. A significant portion of wetlands have been drained and coastal development threatens to result in the further loss of wetlands. The extensive forests, many oak openings and native prairie type environments have been eliminated in the northwestern Ohio lake plain. Clean farming practices have eliminated wildlife habitat along canal, ditch, and farm borders. Farming practices have increased sediment loads, nutrients, and pesticides entering the lake resulting in degraded water quality and in impacts to the fisheries resource and to various avian populations. Industrial and urban areas have also contributed to degraded water quality as well as other forms of environmental pollution.

The U. S. Fish and Wildlife Service has the following concerns regarding any proposed erosion and flood protection plan:

1. Changes in lake current patterns, littoral drift movements, and/or movements of water into and out of estuaries: The effects of these changes may be far-reaching and extremely detrimental to fish and wildlife resources. The effects could range from the local disruption of bottom habitat or spawning beds to long-term shifts in the character of entire aquatic and coastal communities. A change of one or two feet in water depth resulting from the placement of a shore protection structure

without consideration of lake seiche activities may have profound effects on the littoral zone and interconnecting waters. Problems associated with oxygen depletion and concentration of pollutants may increase as a result of lower flows into certain areas. Alternatives should be designed to have a minimal impact on prevailing flow characteristics. An assessment of structure-related impacts would require detailed mapping of nearshore current and of littoral drift patterns as well as a study of flow and water levels in each affected estuary.

2. Reduced dissipation of discharged material from public and private outlets and increased entrainment of aquatic organisms at public and private intakes: A structure located adjacent to or in the vicinity of any warm water discharge could prevent the dissipation of a thermal plume and raise water temperatures to levels lethal to aquatic organisms. A structure located next to an intake channel may increase the number of organisms entrained. The location of public and private outlets and intakes should be identified in the vicinity of each project. Alternatives should attempt to avoid, minimize, or compensate all potential problems associated with siting structures near outlets and intakes.

3. Any channel or floodplain modification of the Ottawa, Maumee, Turtle, Lacarpe , Toussaint, and/or Portage Rivers: Every effort should be made to avoid any channel or floodplain modifications in the aforementioned rivers. Alternatives for such modifications should include the consideration of non-structural alternatives, i.e. floodplain zoning, flood insurance, flood warning systems, and flood proofing. The planting of native vegetation should be considered as an alternative for controlling erosion problem areas along the streambank. Studies will be required to gather baseline data for the assessment of any alternative involving channel or floodplain modifications.

4. Disruption of significant fish habitat including spawning beds, nursery areas, overwintering areas, and migration routes: Spawning habitat requirements for various fish species is generally known, but exact locations of actual spawning beds are unknown. From known spawning habitat preferences one can extrapolate to identify actual spawning beds. Verification comes from intense, frequent sampling. Identification and mapping of lake bottom types would facilitate the location of spawning beds and benthic producing areas. Once identified, plans may be modified to avoid or mitigate destruction of these areas from increased turbidity, increased siltation, and other construction-related impacts. Also, many important game fish are highly migratory, i.e. perch, walleye, white bass, but their movements are relatively unknown. Migratory routes should be identified and structures placed or modified to avoid disruption of fish movements. Alternatives should include consideration of alternate construction materials. While selection of materials would be dependent upon the site and proposed plans, certain materials may be better suited than others in mitigating losses of aquatic habitat. For example, a

gradually sloping shoreline protection structure of riprap material or armor stone generally provides more cover for aquatic organisms than steel sheet piling. But while such a structure can create walleye and white bass habitat, yellow perch or channel catfish habitat may be simultaneously eliminated. Such possibilities of a species "trade-off" should be considered and decisions made according to the needs of the particular area. Another "trade-off" which could result from construction of a shoreline protection structure is the creation of spawning habitat but at the expense of feeding grounds or vice versa. Only a site specific study can determine which alternative is best.

5. The destruction, reduction, or modification of wetlands: Wetland communities play an important and oftentimes essential role in the life histories of many fish and wildlife species. There is a general need for surveying wetland areas, including estuaries. Studies should include ichthyoplankton, benthos, fish and mammal sampling, vegetative analysis and data regarding migrating birds, breeding birds, and waterfowl, and endangered species surveys. Ichthyoplankton sampling should be conducted at least three times during spring, summer, and fall and at least three times during a given sampling day to account for diel migrations. Benthos and adult fish should be sampled every season and more than once per season, since schooling fish species make interpretation of sampling data difficult. Several gear types, i.e. gill nets, seines and fine-mesh trawls, should be used to eliminate as much sampling bias as possible. Sampling techniques must be capable of including bottom species, such as darters and sculpins. A vegetative analysis should include a vegetative cover map and determination of the presence or likelihood of presence of rare or unusual plant species in the area. Migrating bird surveys should be conducted in spring and in fall. Breeding bird surveys should be conducted in spring through early summer. Waterfowl use and production should be studied. A determination of the presence or the likelihood of the presence of endangered species should be made. The interdependent relationships between the lake and wetland areas should be investigated prior to implementation of any proposed action in the vicinity of a wetland area. Alternatives should be designed such that the interdependent relationships between lake and wetland evironments are avoided, minimized, or restored.

6. The destruction, reduction, or modification of undeveloped terrestrial environments: Alternatives should not encourage additional development along shorelines and in flood plain areas. Habitats such as oak openings and prairie environments are disappearing as a result of land use changes. These uncommon and unique environments should be identified, and impacts to these environments should be avoided or mitigated.

7. Significant declines in wildlife population, or potential threats to vulnerable wildlife populations: Certain species in the southwestern Lake Erie area are more vulnerable to decimation of their population due to either a) their concentration in very local areas, i.e. colonial nesting birds;

b) their strict preference for a habitat type of limited availability, i.e. marsh birds; and/or c) their currently low population numbers, i.e. bald eagle. Potentially vulnerable species and resource areas upon which these species depend should be identified where they exist in or near proposed project areas. Alternatives should avoid or mitigate impacts to these species and any significant resource base upon which they depend.

8. Effects to endangered species: This report does not fulfill the requirements of Section 7 of the Endangered Species Act of 1973, as amended. A list of Endangered Species that may be found in the project area or consultation on known Endangered Species that may be found in the project area should be requested from the Regional Director, U. S. Fish and Wildlife Service, Federal Building, Fort Snelling, Twin Cities, Minnesota 55111.

9. Conflicts with goals of private, state, and federal fish and wildlife management areas: Private, state, and federal fish and wildlife management areas are important resources areas in the southwestern Lake Erie area. They provide habitat needs for numerous species of fish and wildlife as well as provide opportunities for public fishing, hunting, recreation, and education. A project which significantly increases public access and use of areas adjoining wildlife areas may disturb wildlife, encourage trespassing, and create other management problems for wildlife management areas. An ill-planned structure may increase damage to existing dike systems. An assessment of possible effects should be made of each alternative planned in the vicinity of such areas. Alternatives should attempt to avoid, mitigate,or compensate for adverse effects.

Additional studies of fish and wildlife resources may be needed in order to adequately assess the effects of any proposed erosion or flood protection structure. Upon close examination, existing data are either outdated, lacking for certain areas, largely unreviewed data compiled for grant-funded projects, or collected for specific legal purposes, i.e., impact assessment. These data sources are limited in their scope and usefulness for general background information necessary for the biological evaluation of nearshore areas. Unpublished, unreviewed file data from government agencies, educational institutions, libraries and individuals are extensive, but not of uniform quality. Therefore, massive efforts would be required to locate and compile this information into a useful form. At this time, we stress the importance of conducting site-specific studies. Each site should be regarded as different and requiring its own study. Site-specific studies should attempt to achieve the objectives outlined under the applicable concerns (1-9) stated above.

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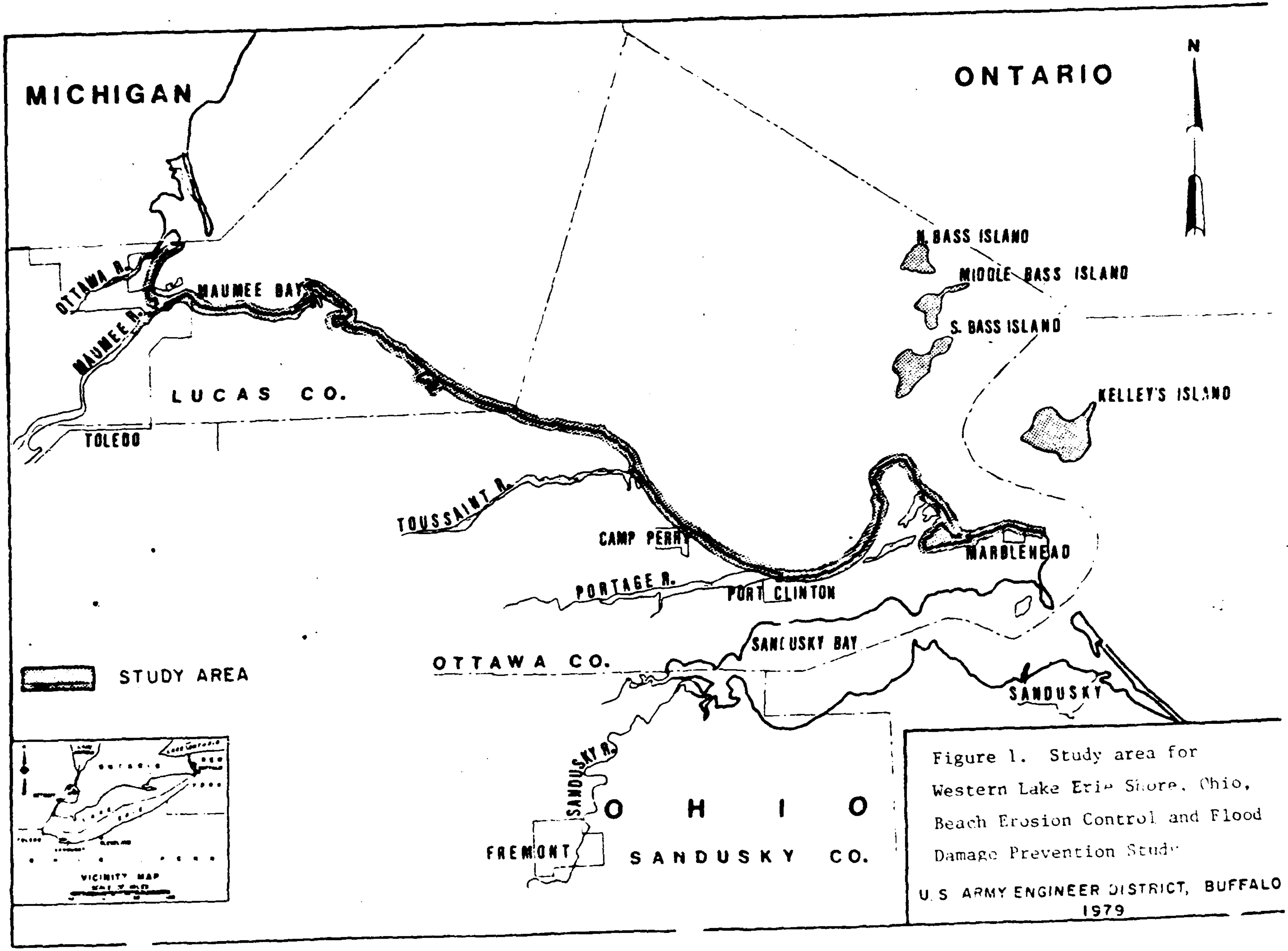


Figure 1. Study area for Western Lake Erie Shore, Ohio, Beach Erosion Control and Flood Damage Prevention Study

U.S. ARMY ENGINEER DISTRICT, BUFFALO
1979

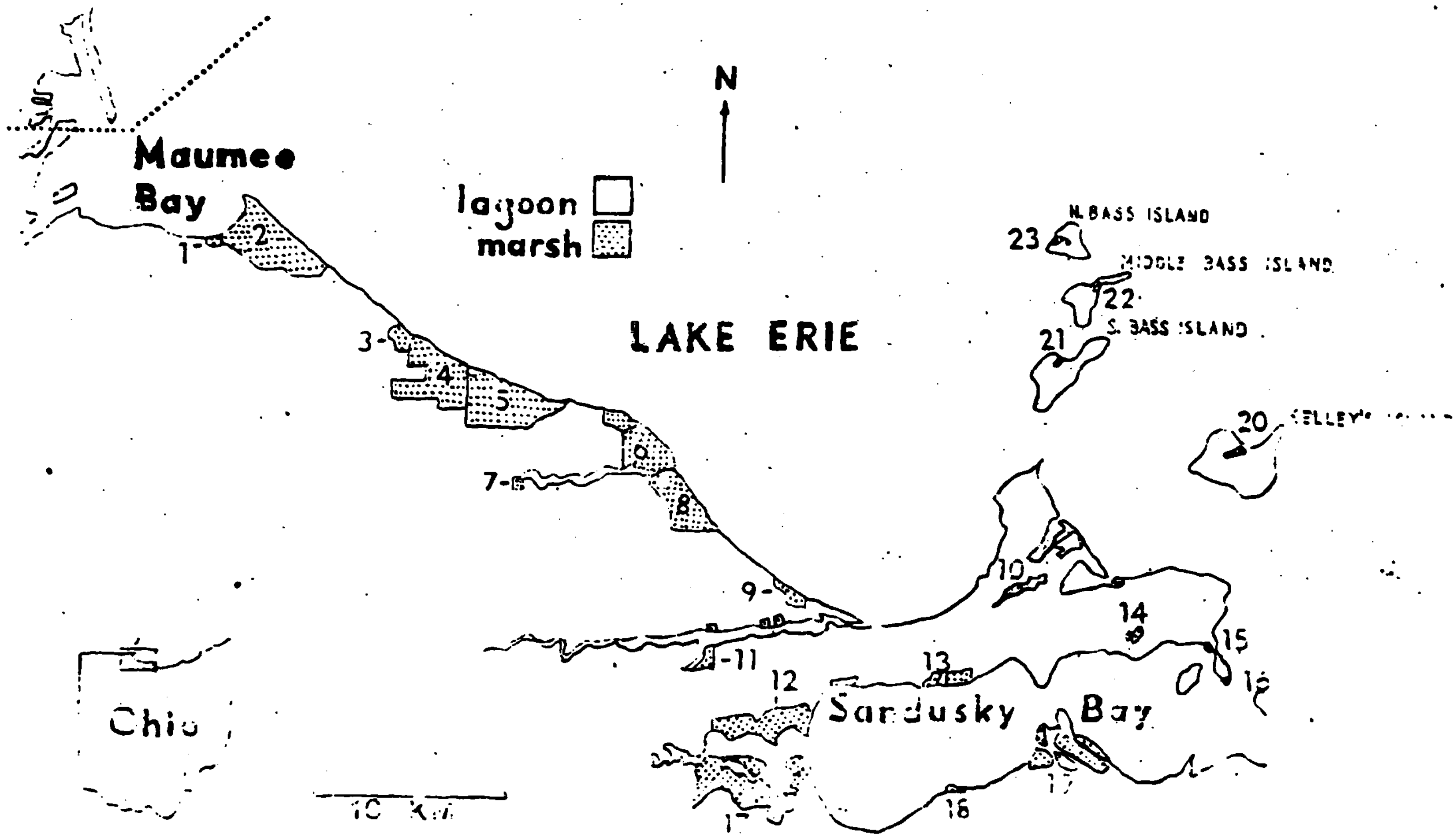


Figure 2. Significant wetlands of the southwestern Lake Erie and northwestern Ohio area

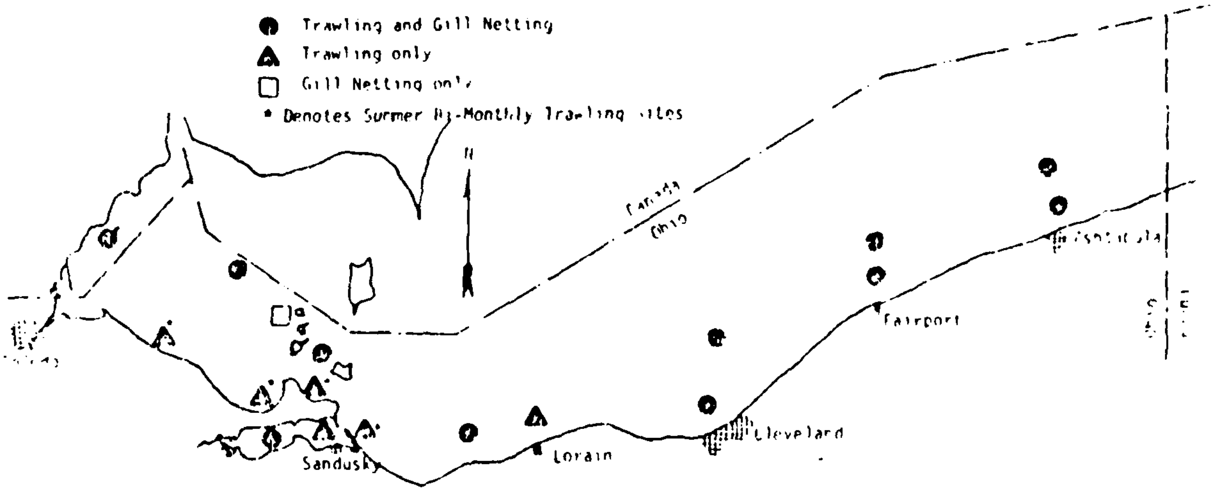


Figure 3. Location of trawling and gill netting stations.

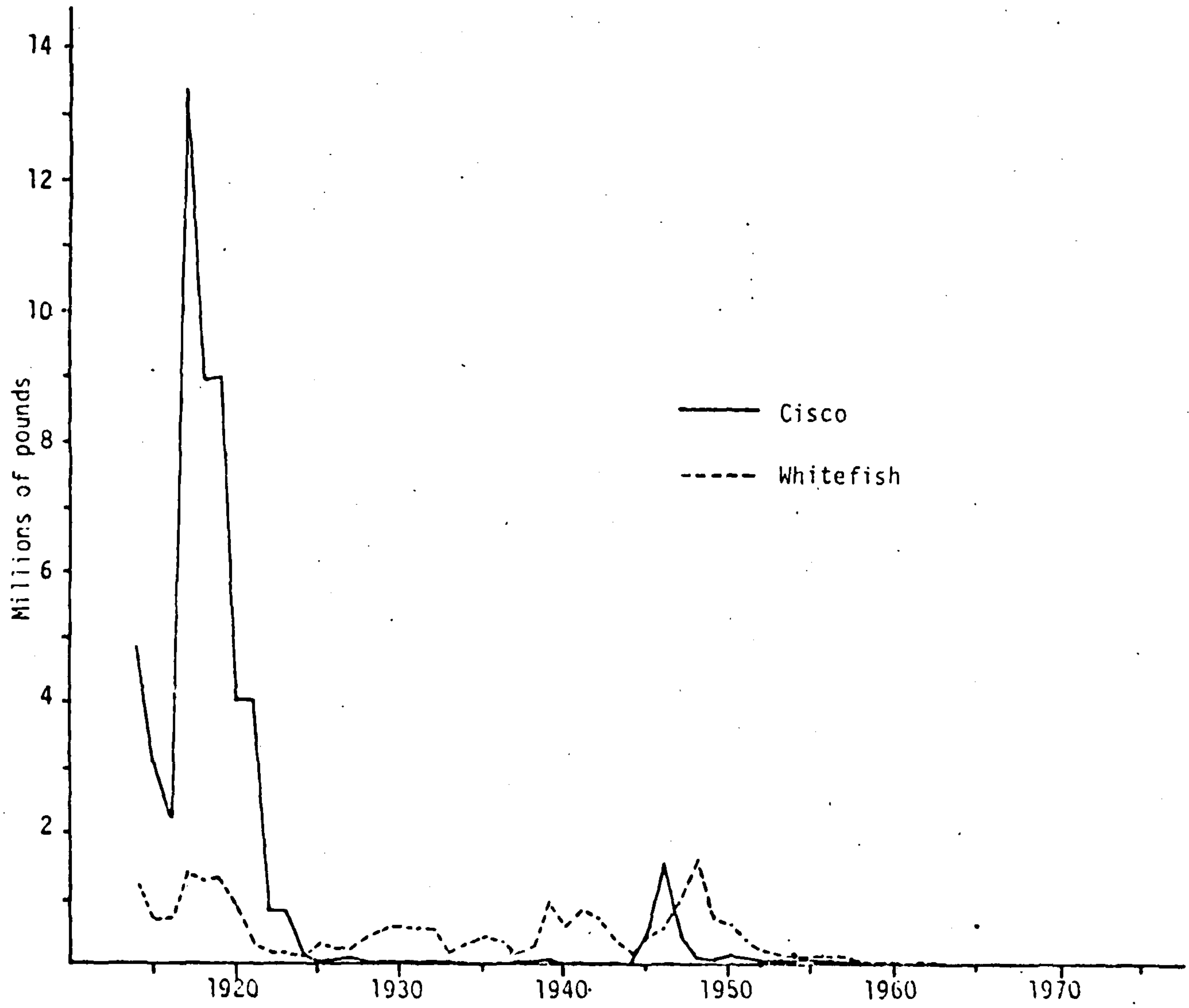
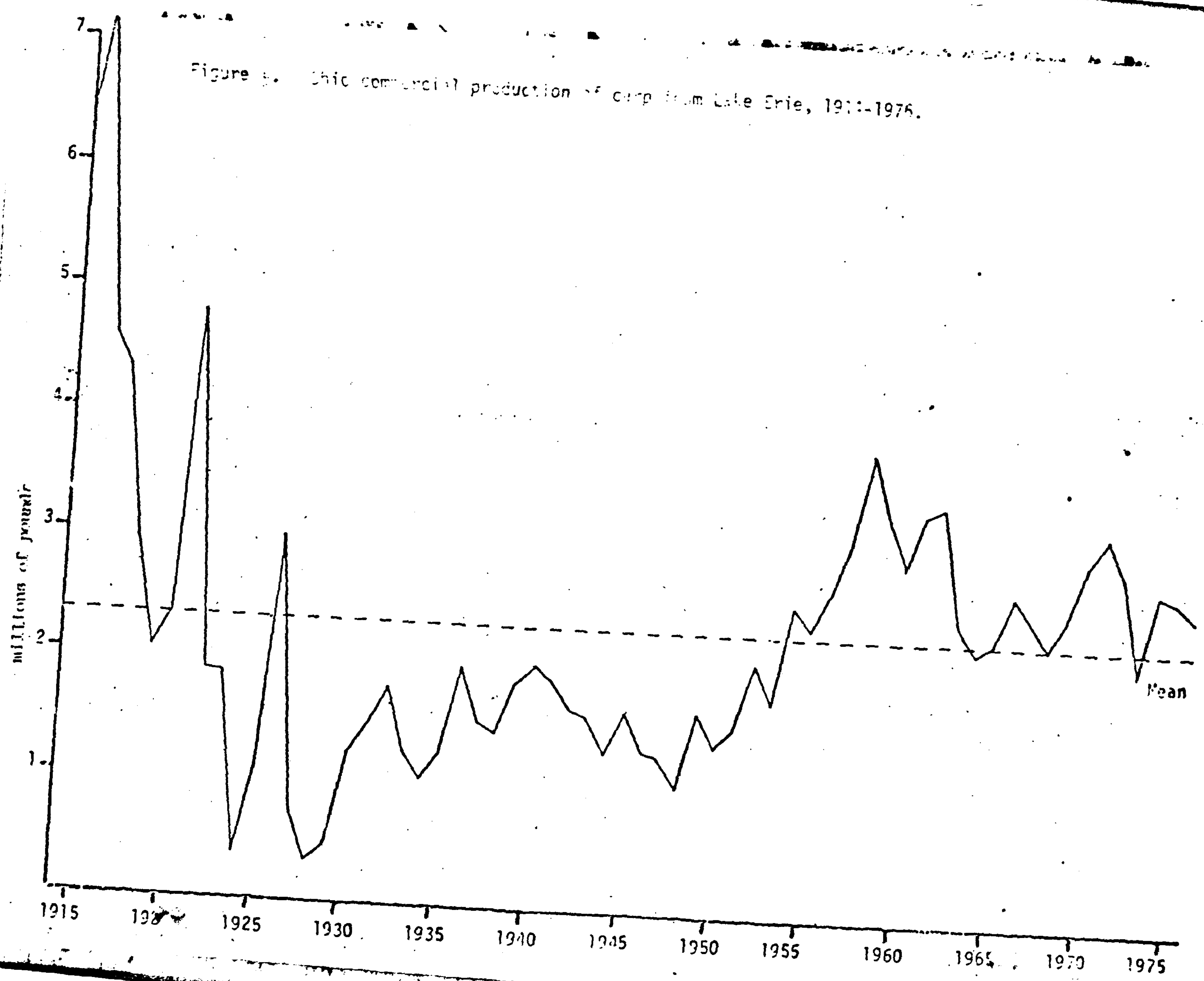


Figure 4. Ohio commercial landings of whitefish and cisco, 1914-1976.

Figure [illegible]. Ohio commercial production of carp from Lake Erie, 19[illegible]-1976.



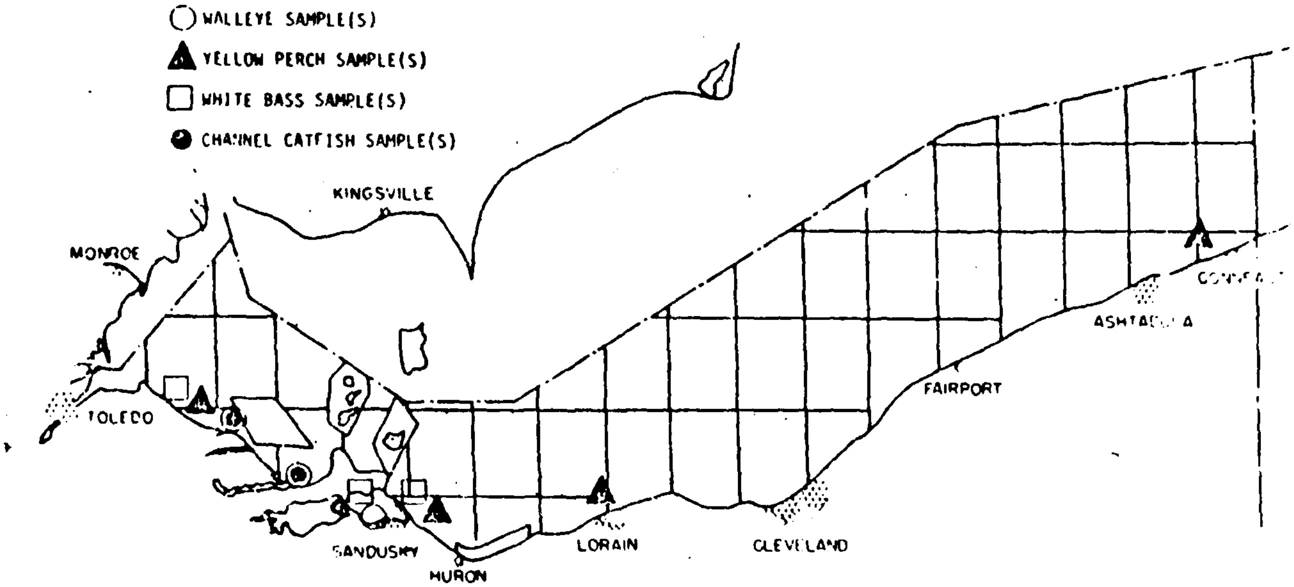


Figure 6. Locations of net run commercial samples.

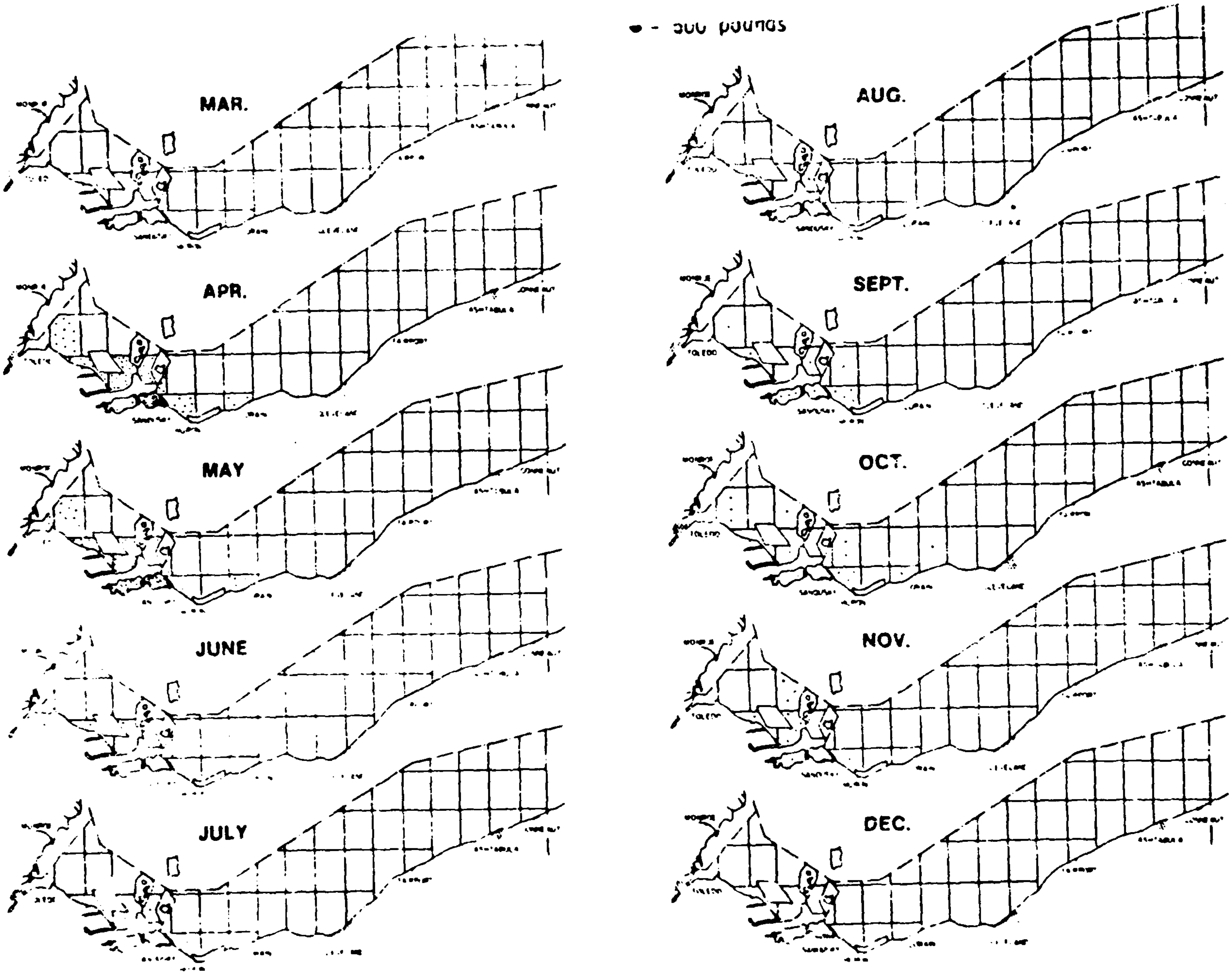
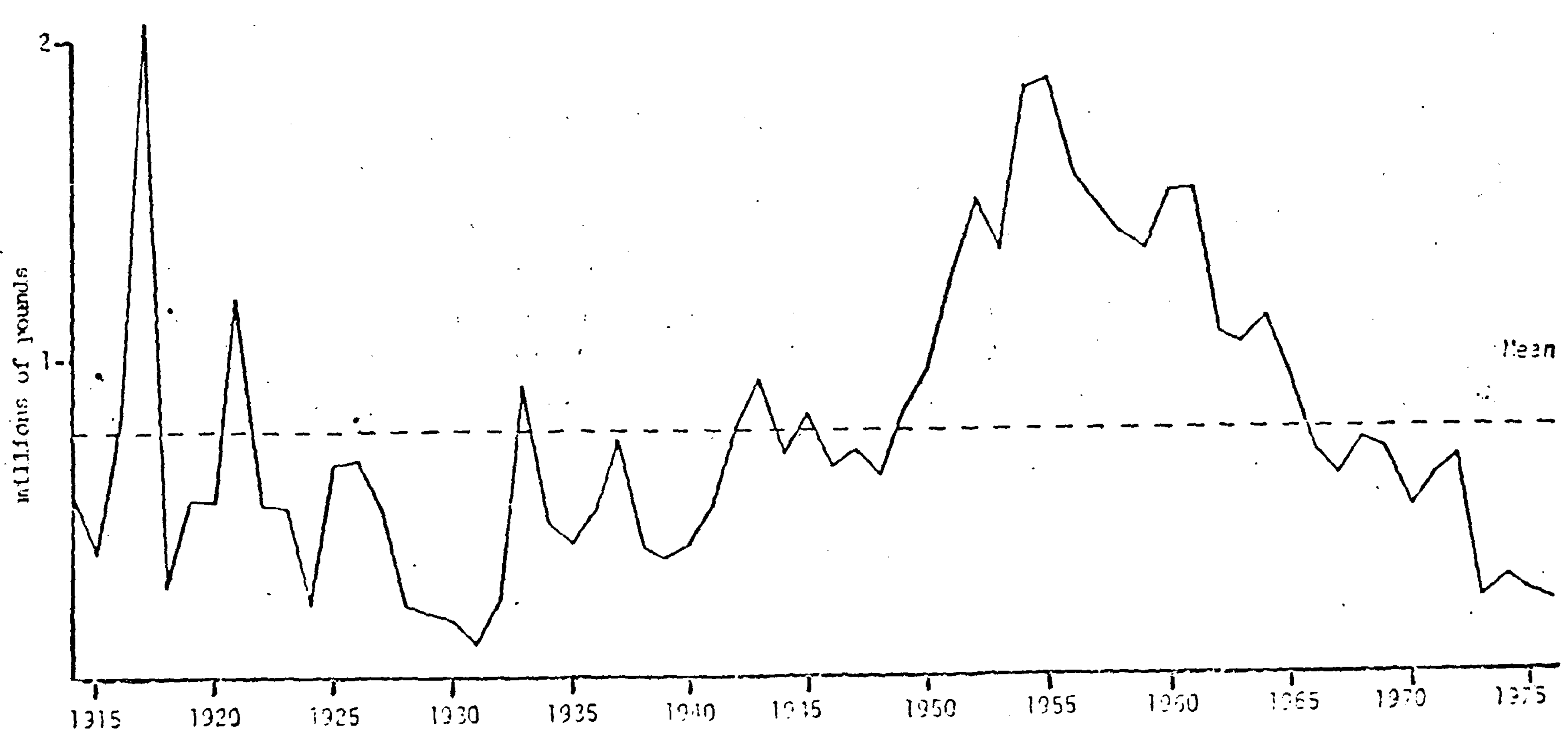
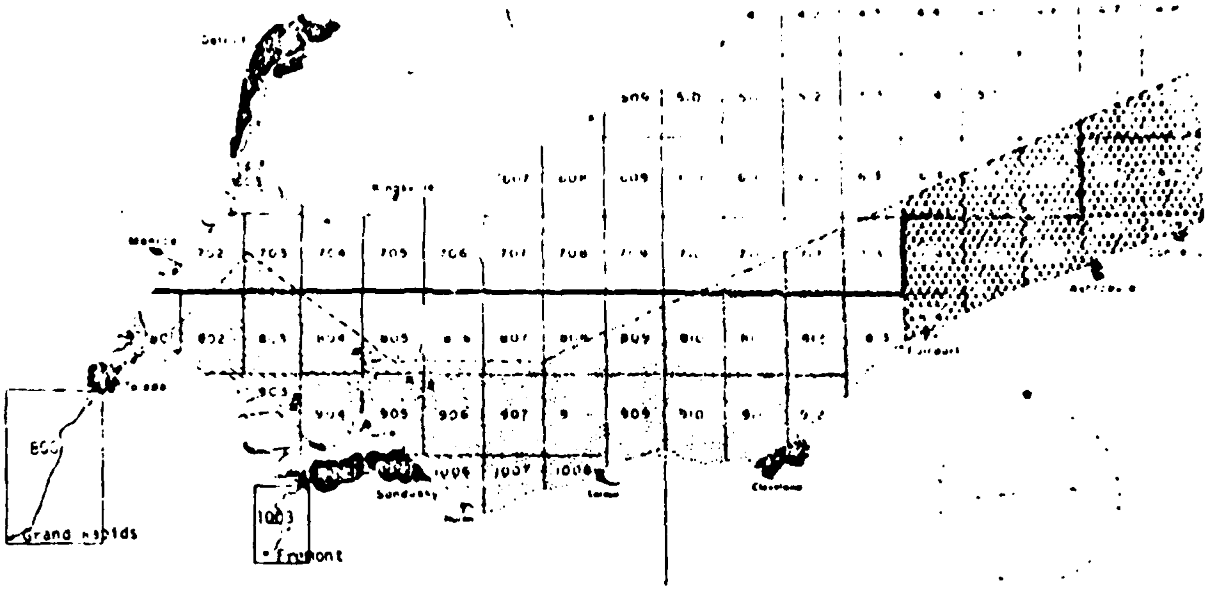


Figure 7. Monthly distribution of channel catfish harvest.

Figure 8. Ohio commercial production of channel catfish from Lake Erie, 1914-1976.





KEY

District I

District II

District III

District IV

------ U. S.-Canada Border

Creel Census Boundary

Figure 9. Creel survey grid and district system.

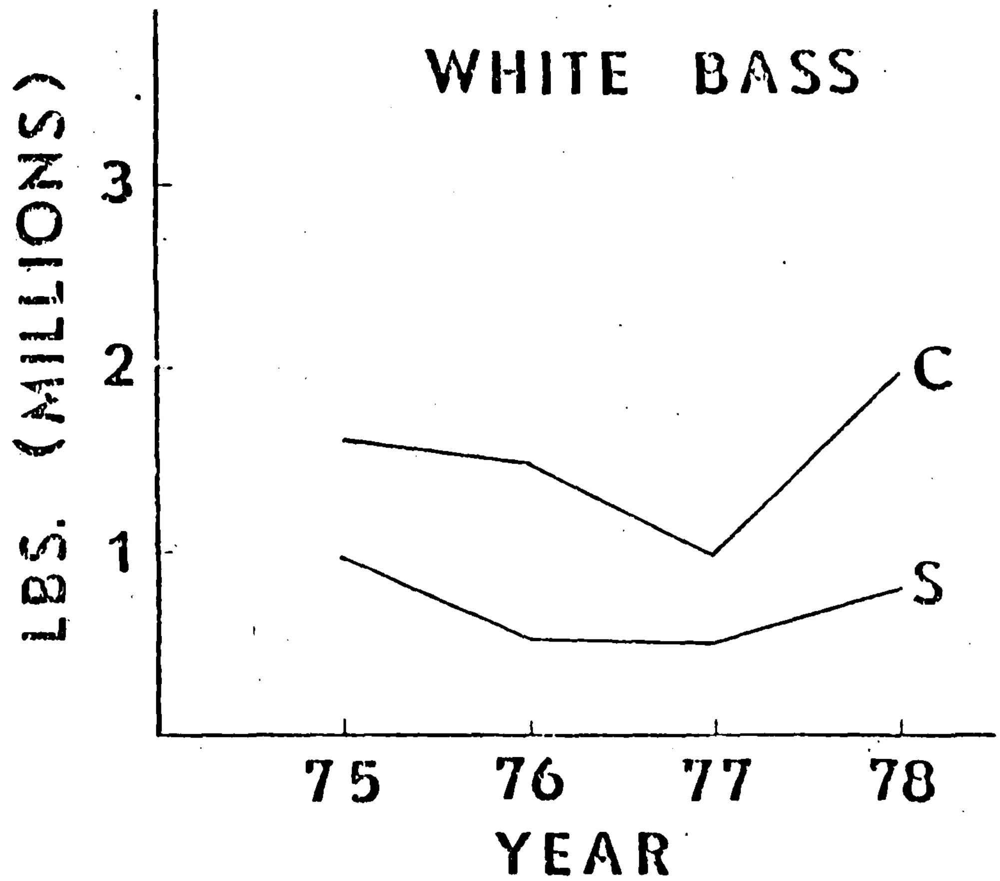


Figure 10. White bass commercial and sport harvest trends.

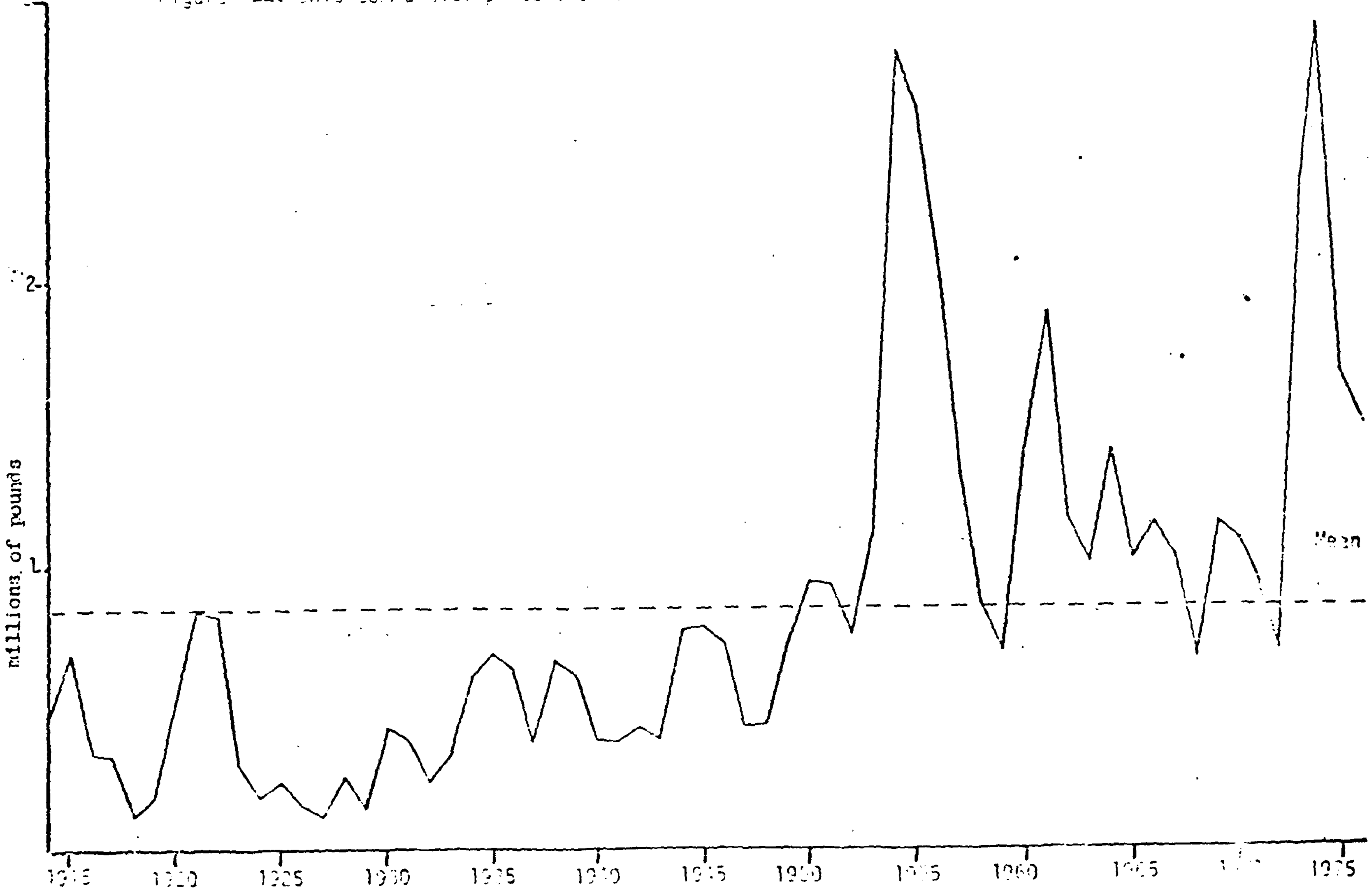


Figure 11. Ohio commercial production of white bass from Lake Erie, 1914-1976.

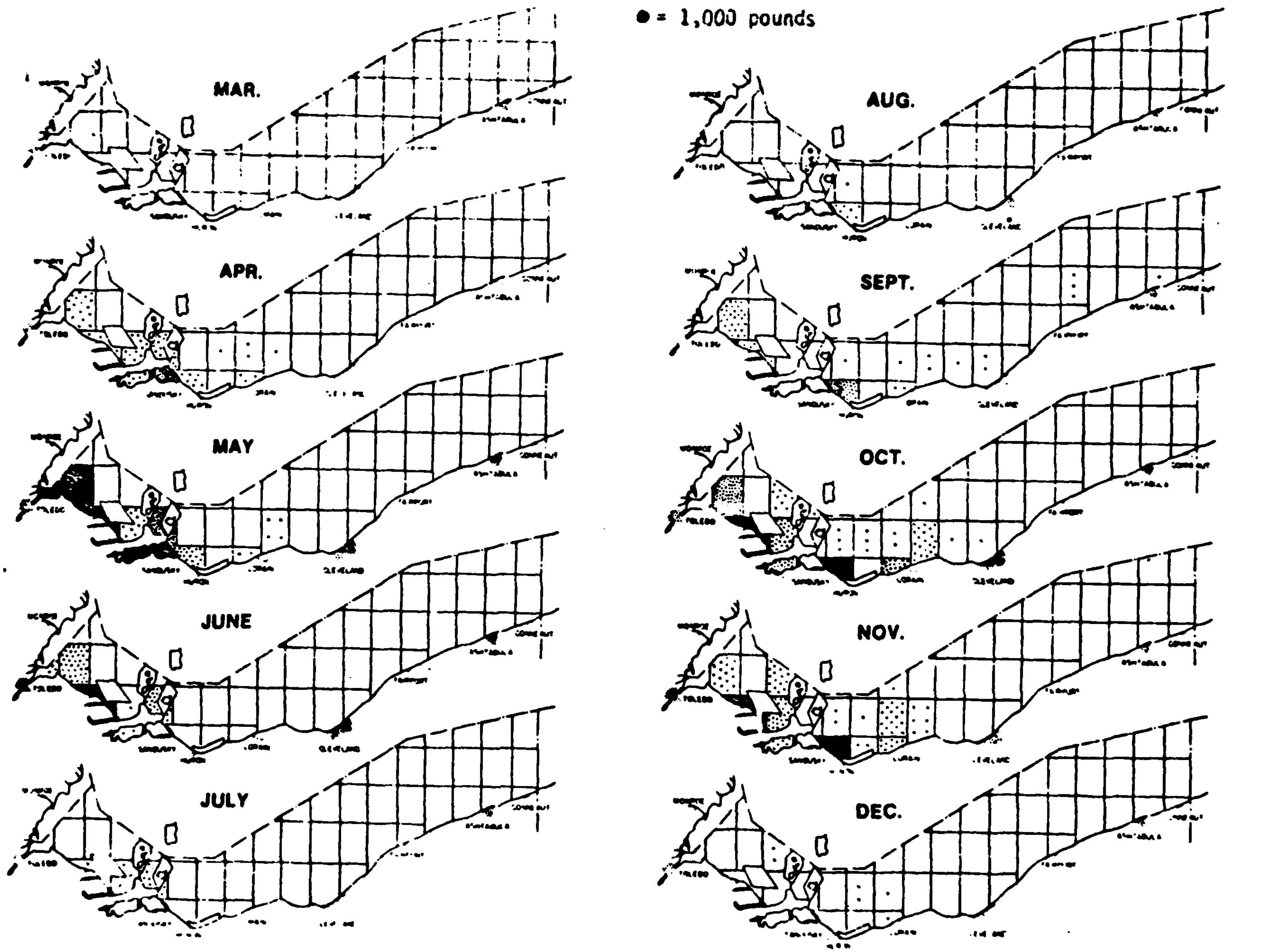


Figure 12. Monthly distribution of white bass harvest.

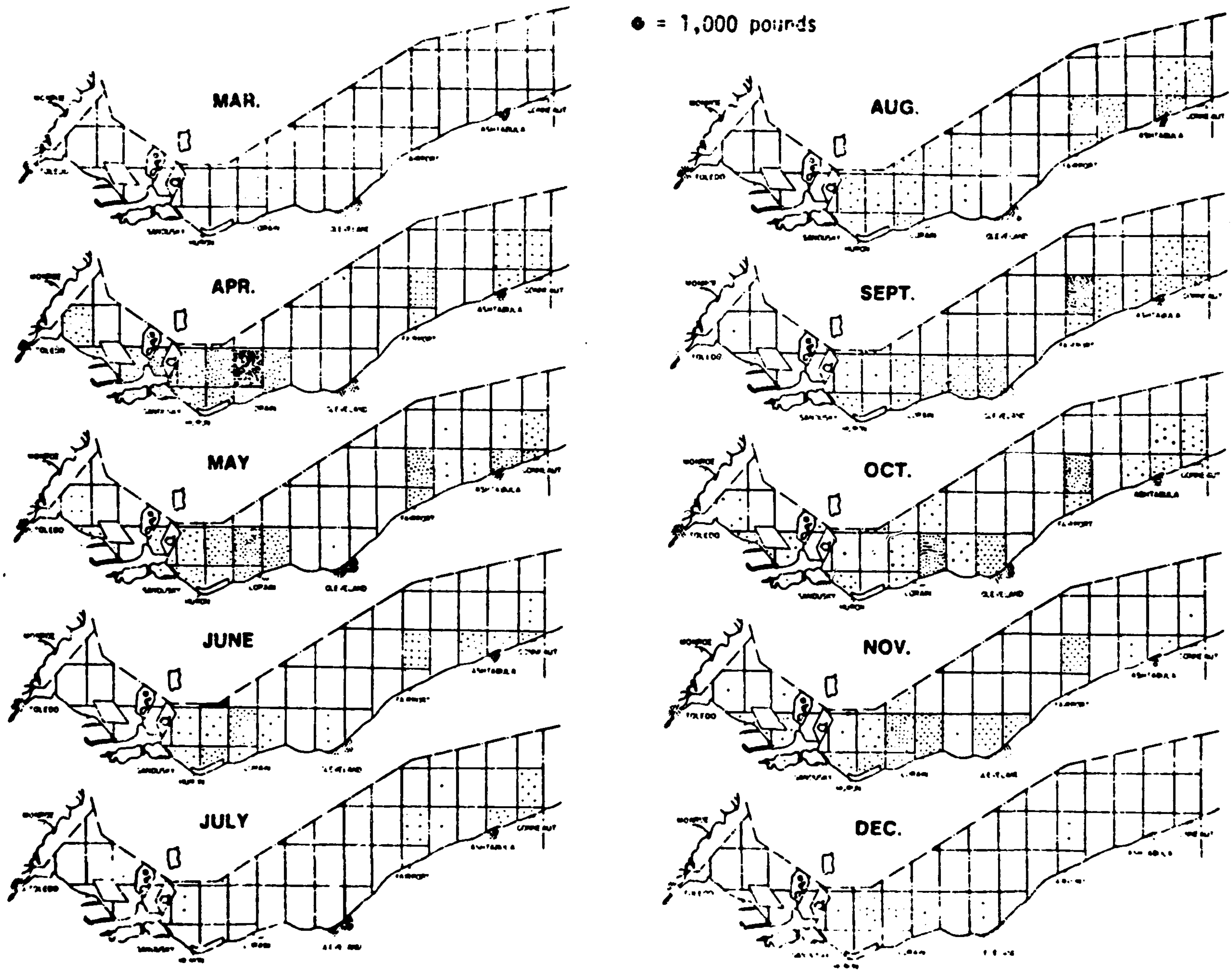
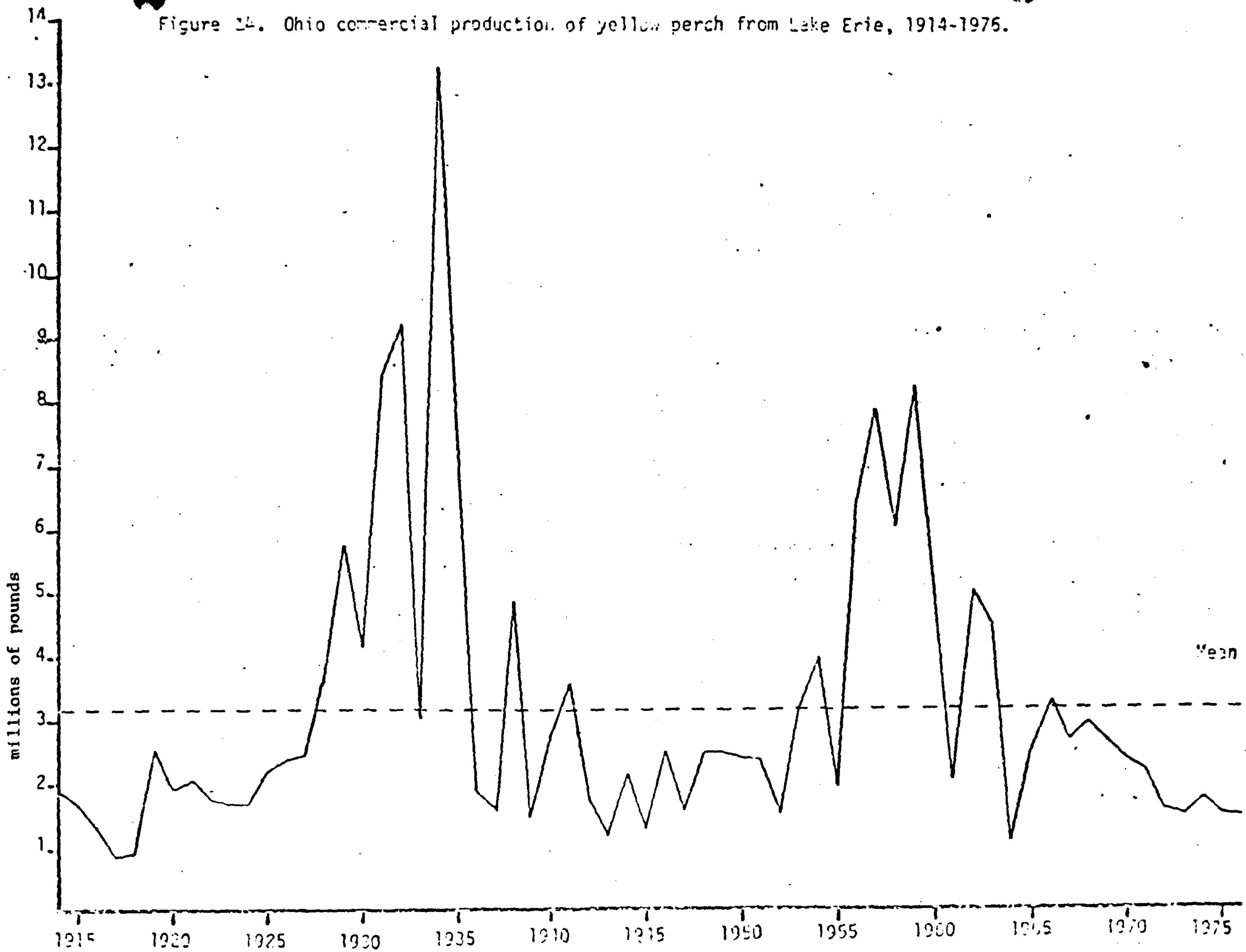


Figure 13. Monthly distribution of yellow perch harvest.

Figure 14. Ohio commercial production of yellow perch from Lake Erie, 1914-1976.



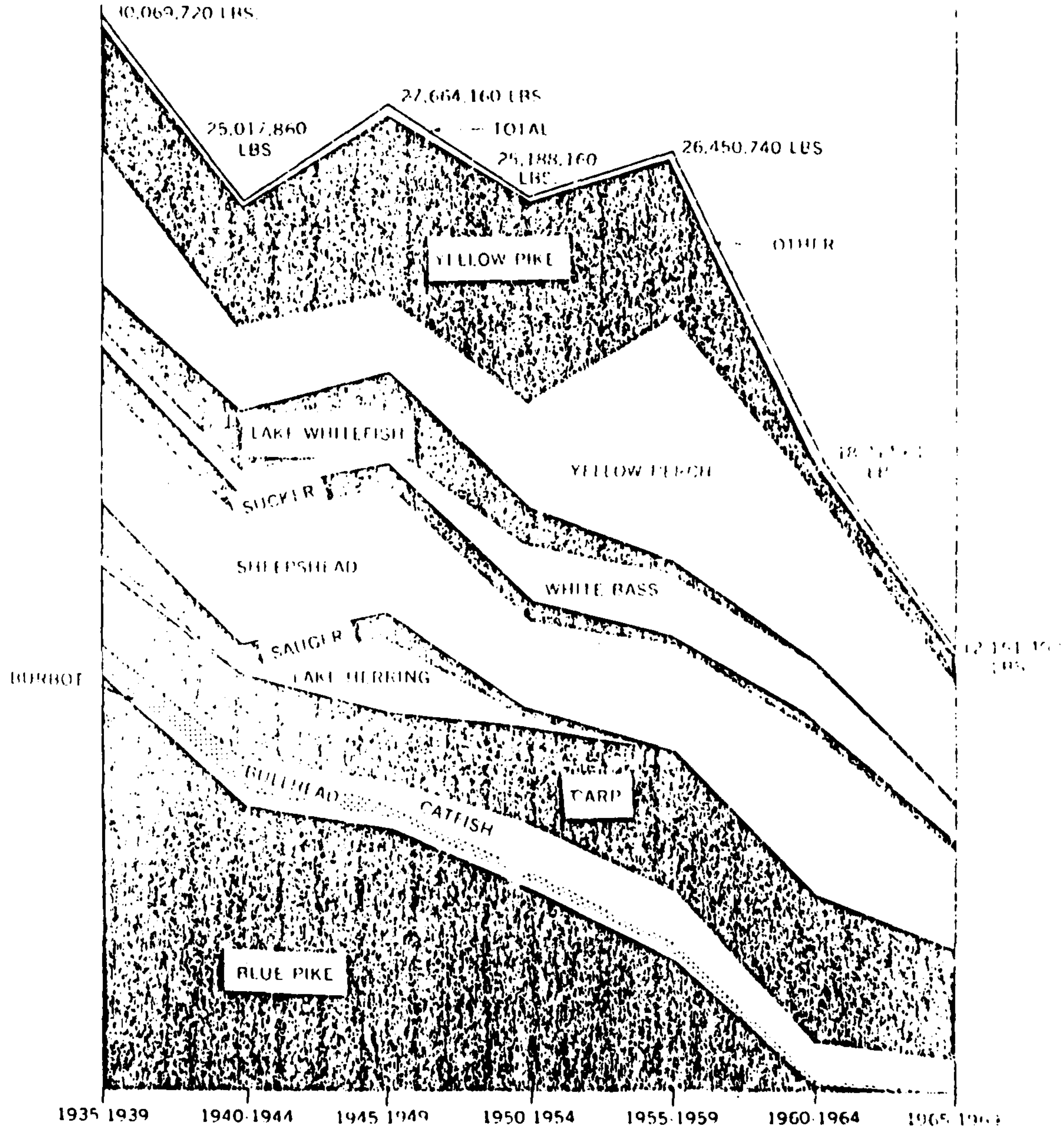
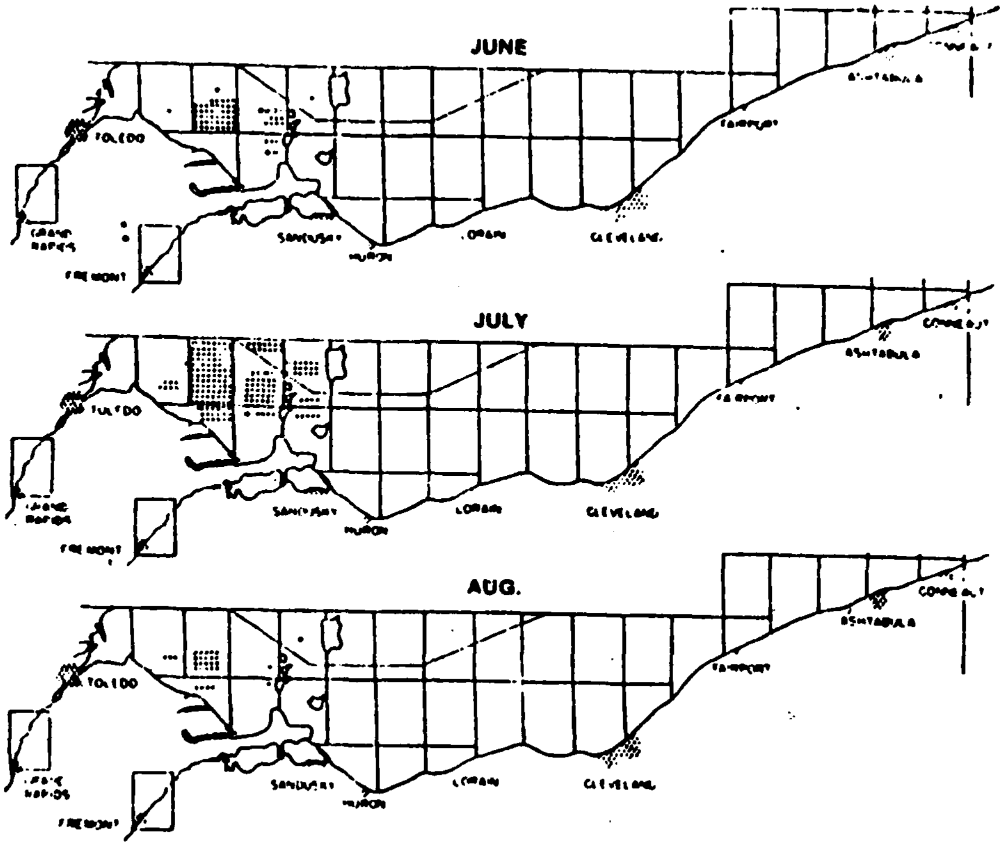


Figure 15. Historical changes in the relative species composition of the Lake Erie fish community (Great Lakes Basin Commission, 1975a)



● = 5,000 fish

Figure 16. Walleye catch by grid, 1978.

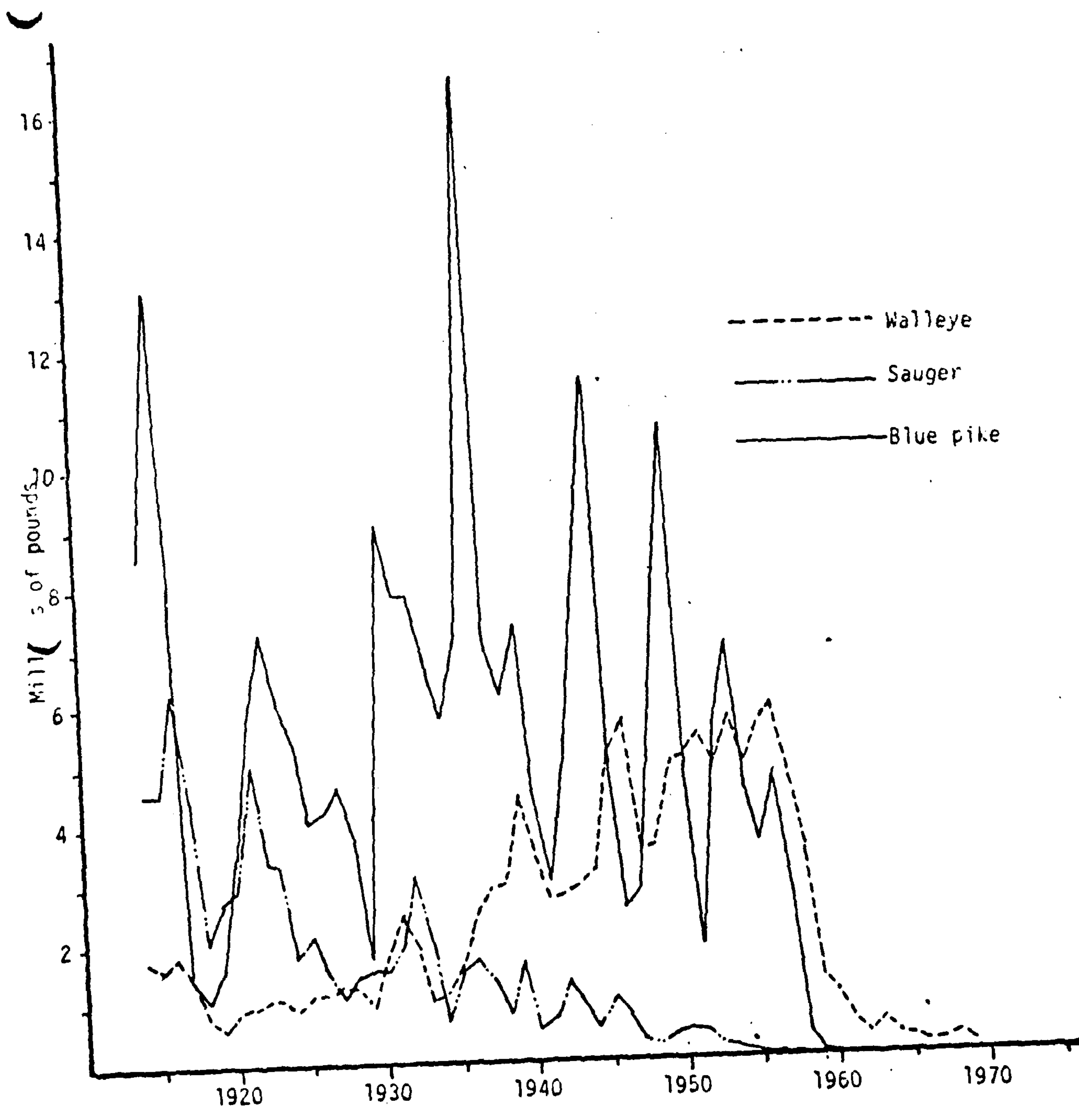
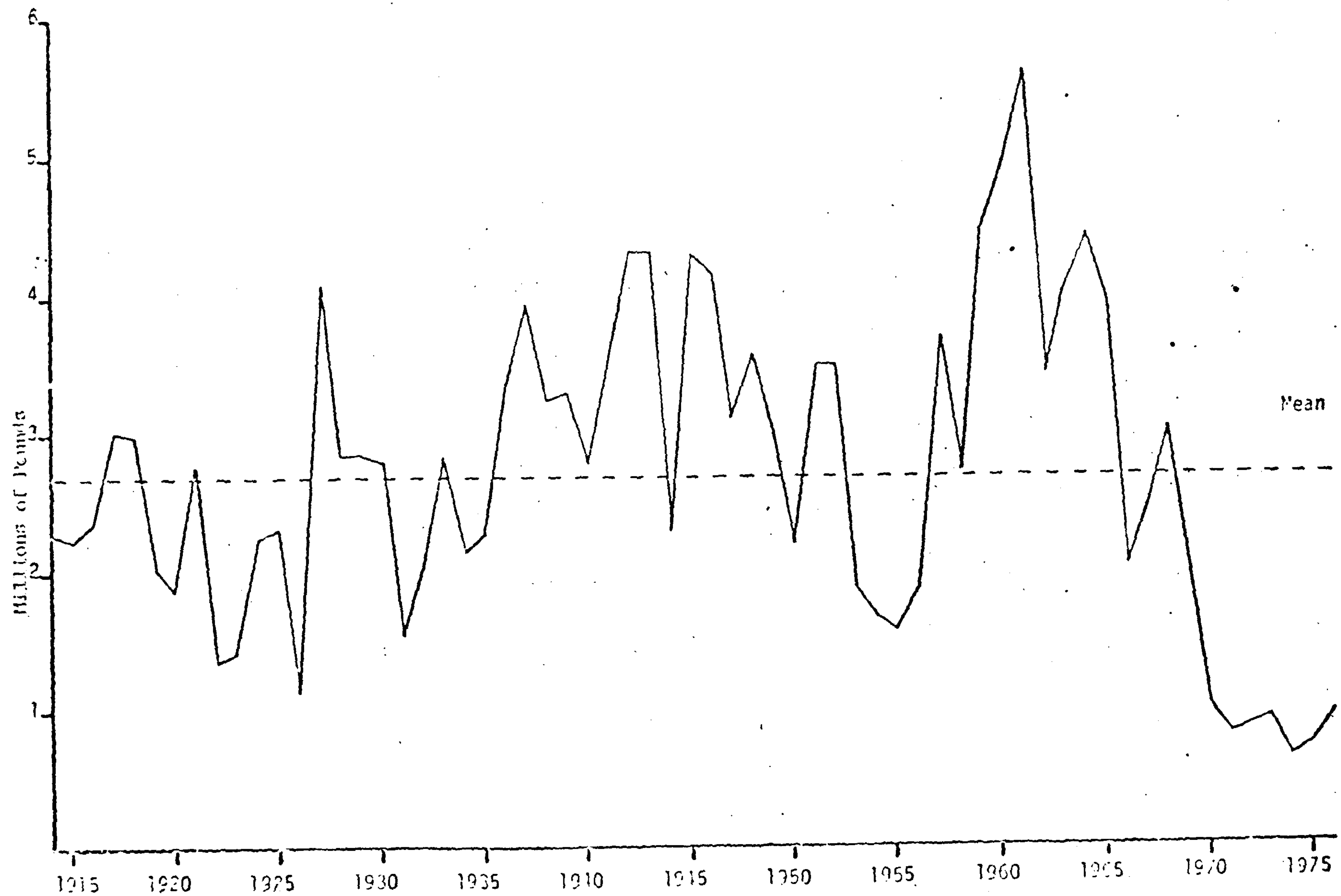


Figure 17. Ohio commercial landings of walleye, sauger and blue pike, 1914-

Figure 15. Ohio commercial production of freshwater drum from Lake Erie, 1914-1976.



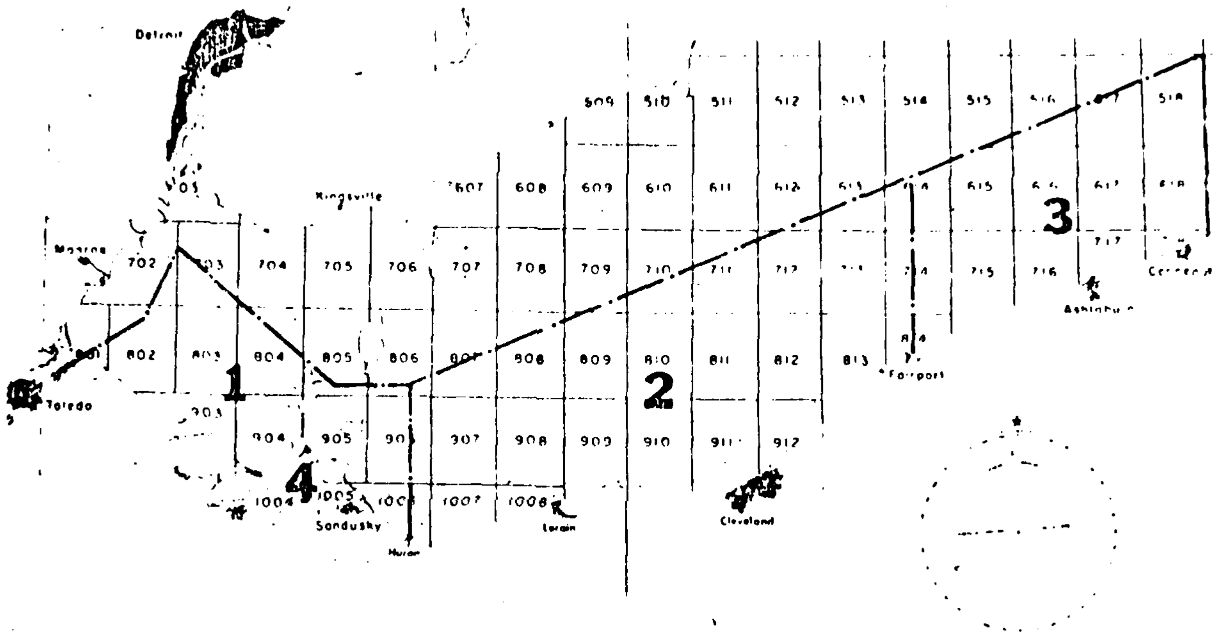
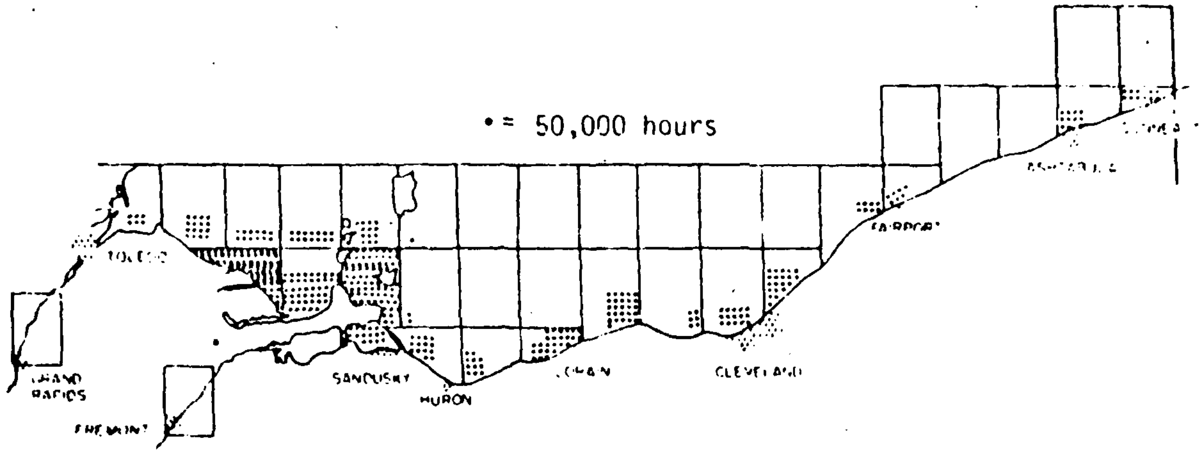
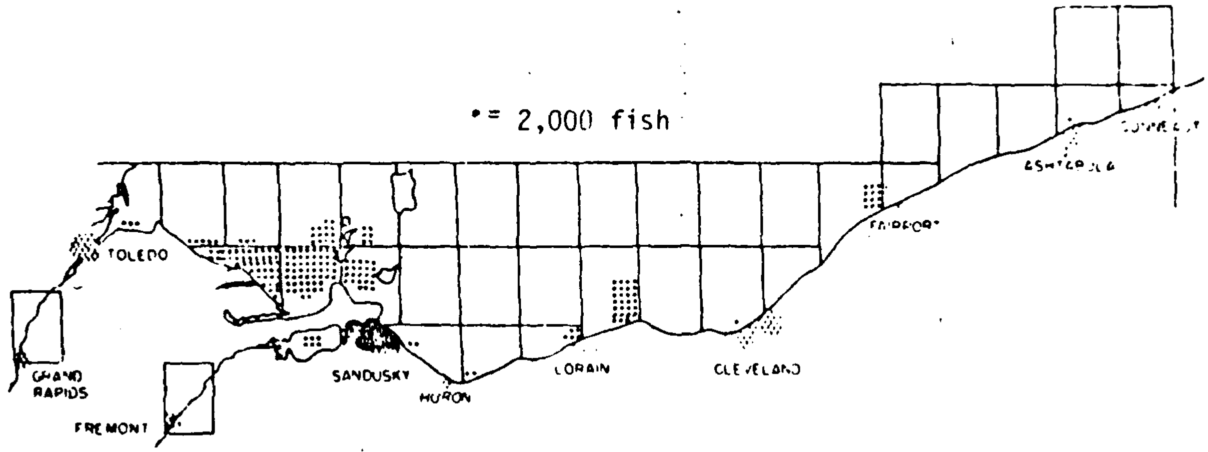


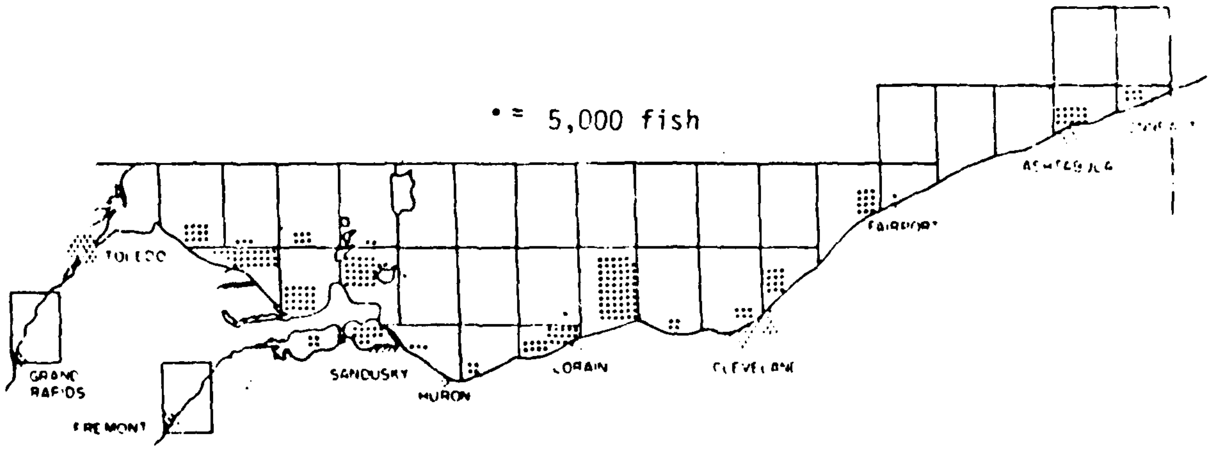
Figure 19. Districts as delineated by Ohio Division of Wildlife for trawling records.



Lake Erie boat angler grid hours 1975-1977.



Channel catfish boat angler grid harvest 1975-1977.



Freshwater drum boat angler grid harvest 1975-1977.

Figure 21. Lake Erie boat angler grid harvest.

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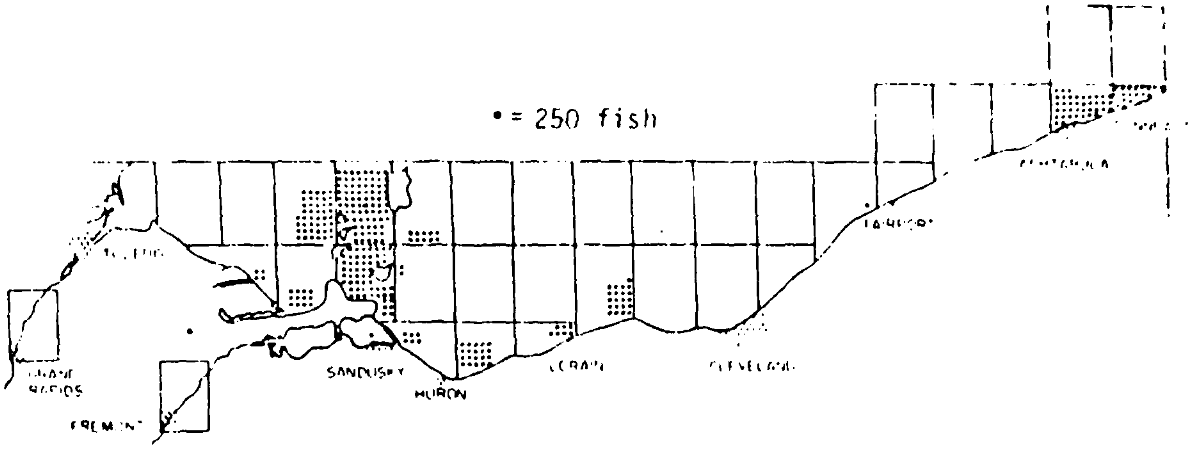
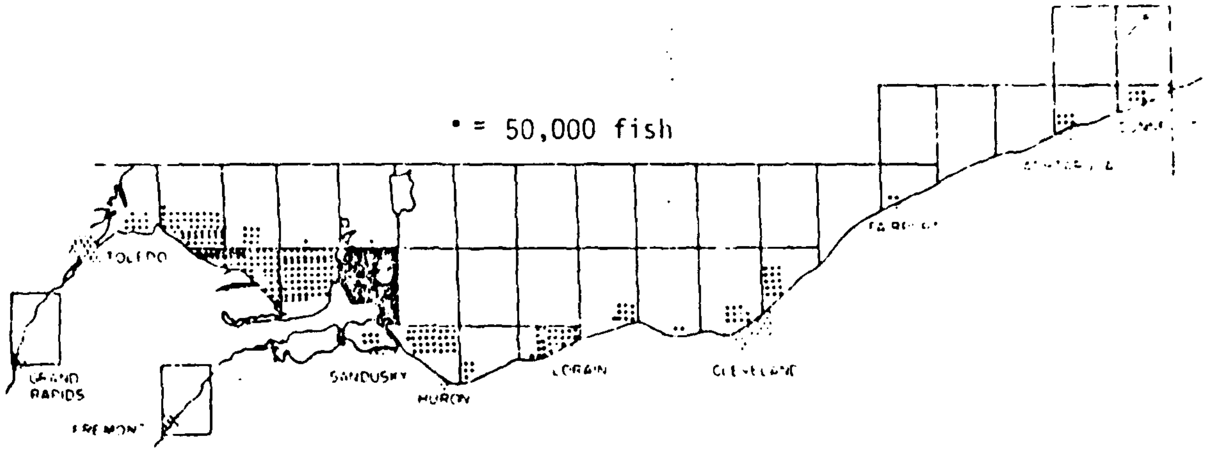
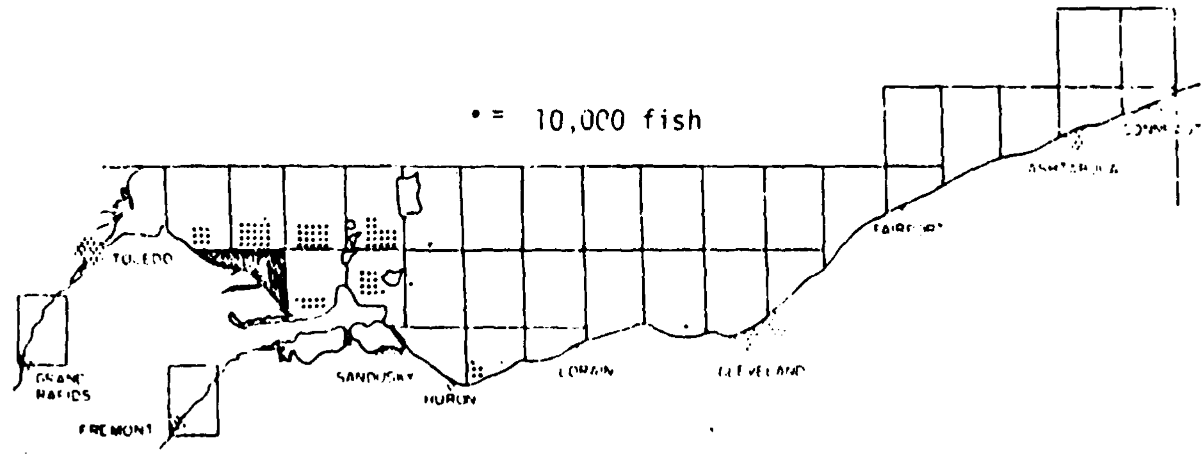


Smallmouth bass boat angler grid harvest 1975-1977.

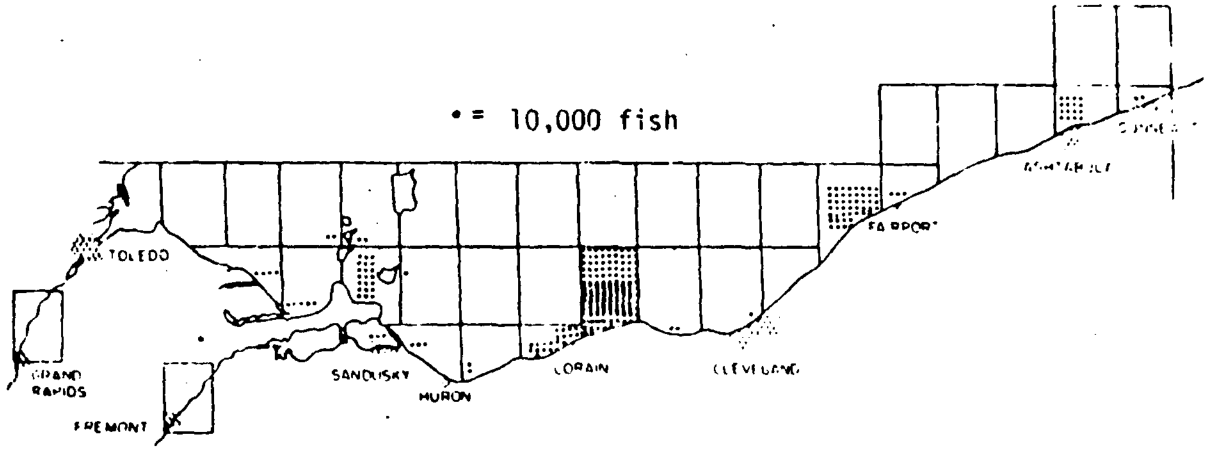


Yellow perch boat angler grid harvest 1975-1977.

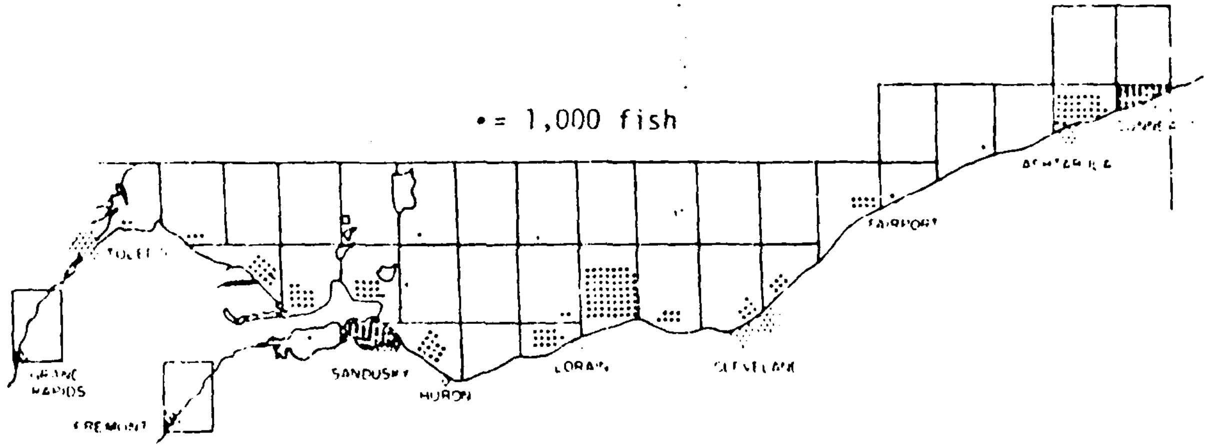


Walleye boat angler grid harvest 1975-1977.

Figure 21. Lake Erie boat angler grid harvest (continued)



White bass boat angler grid harvest 1975-1977.



Other species boat angler grid harvest 1975-1977.

Figure 21. Lake Erie boat angler grid harvest (continued)

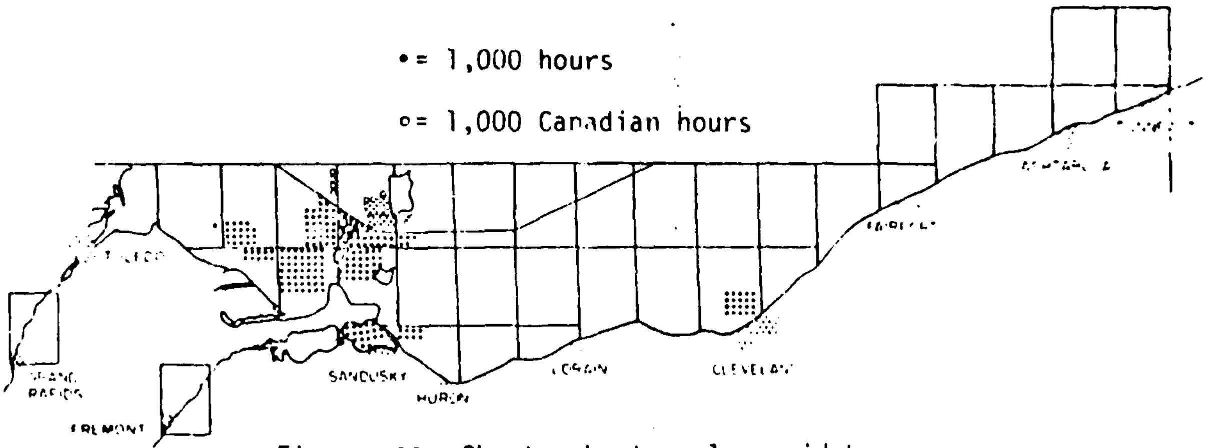


Figure 22a. Charter boat angler grid hours.

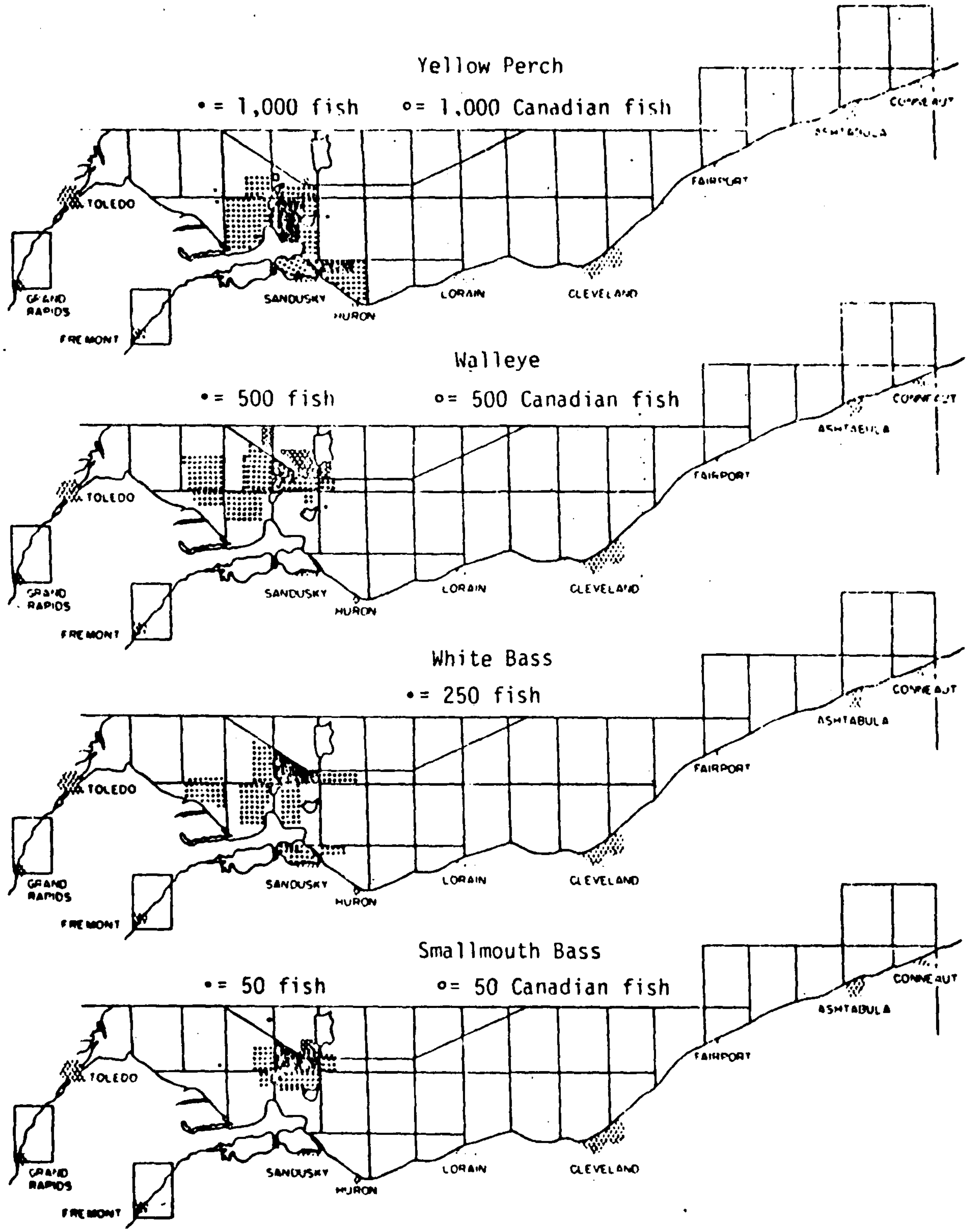
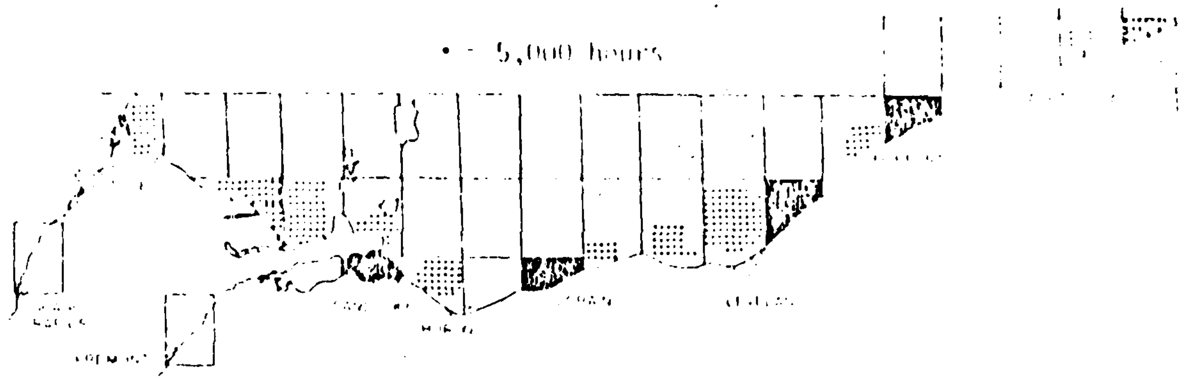
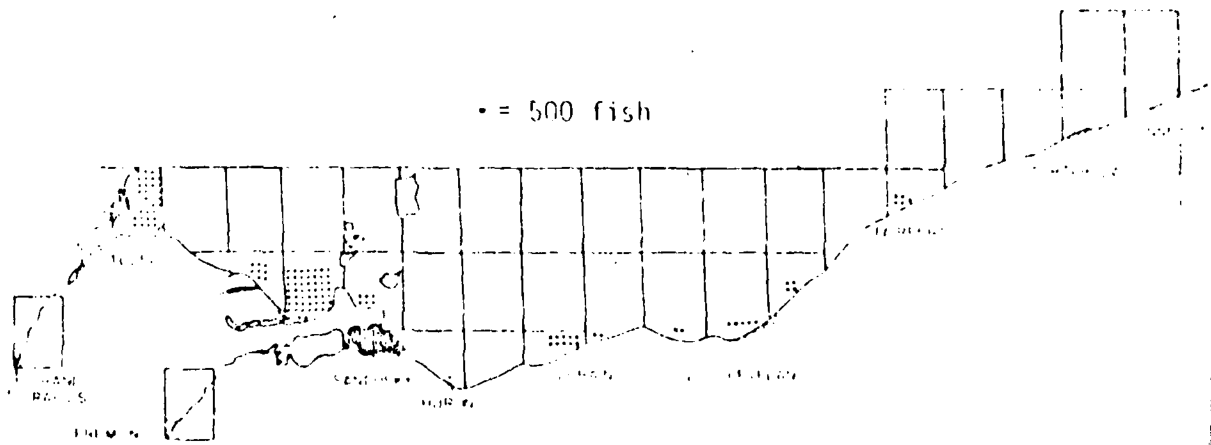


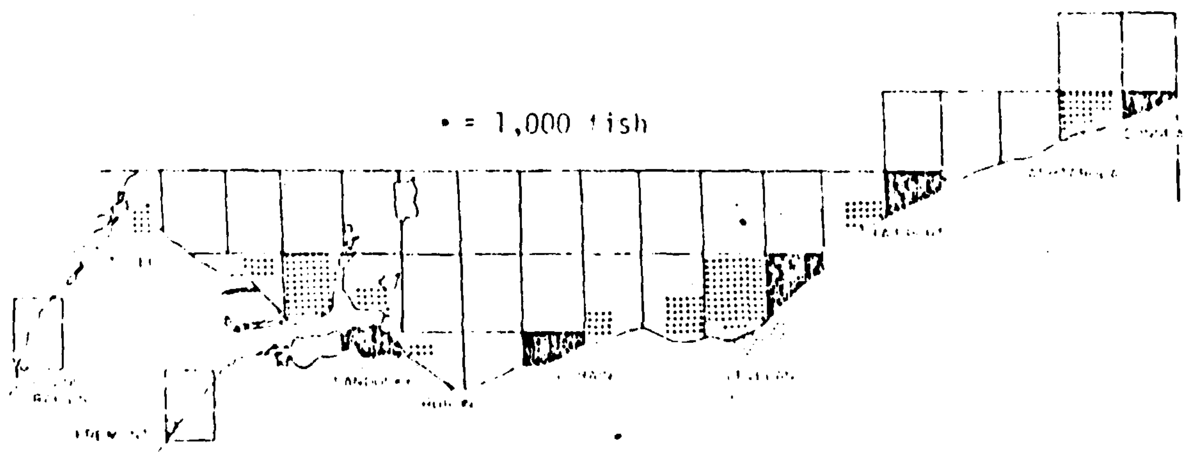
Figure 22b. Charter boat grid harvest for major species 1975-1977.



Lake Erie shore angler grid hours 1975-1977.

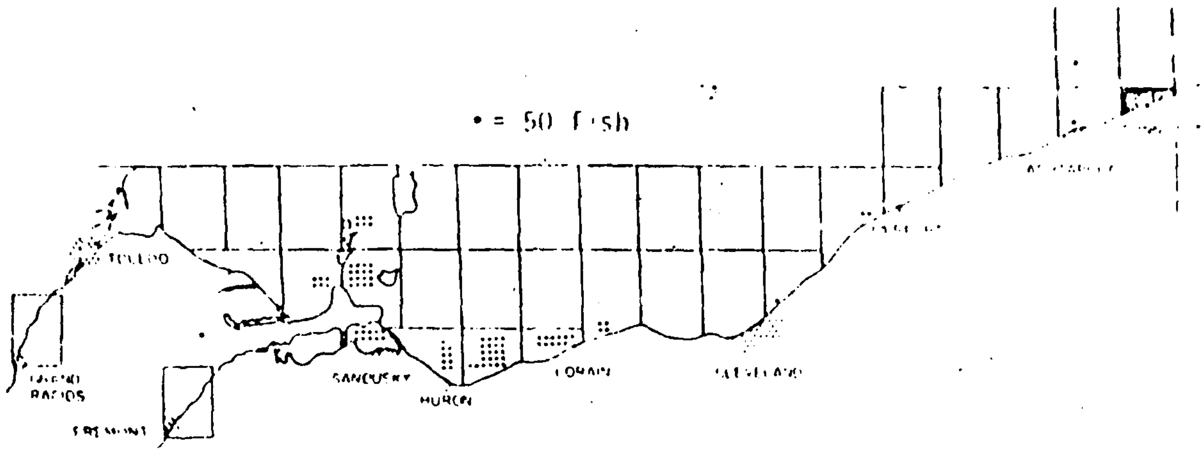


Channel catfish shore angler grid harvest 1975-1977.

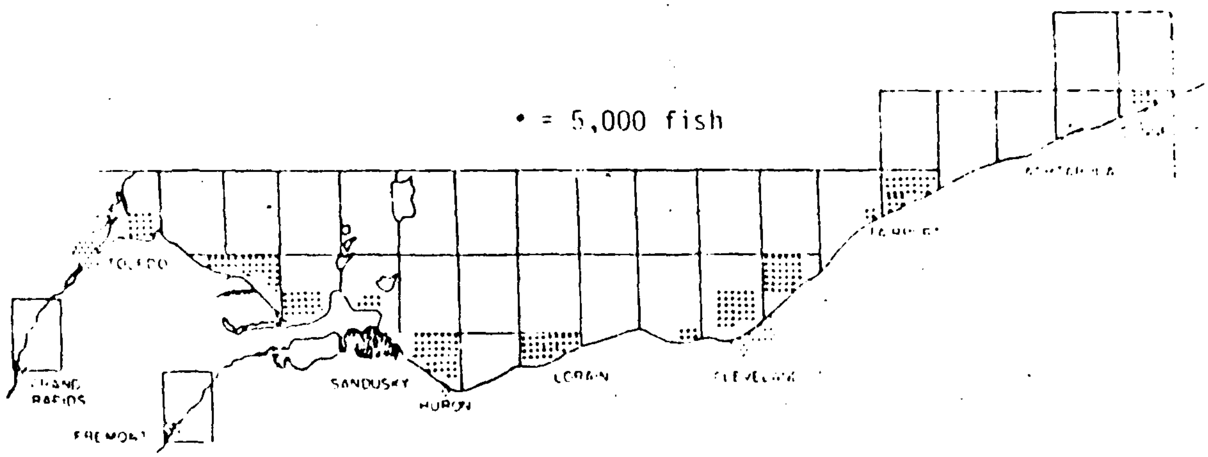


Freshwater drum shore angler grid harvest 1975-1977.

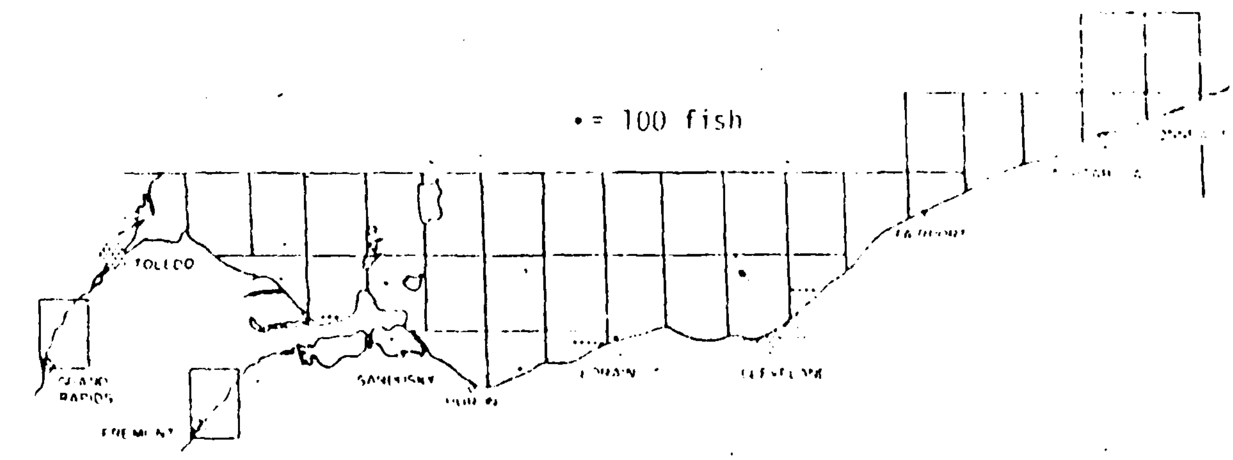
Figure 23. Lake Erie shore angler grid harvest.



Smallmouth bass shore angler grid harvest 1975-1977.

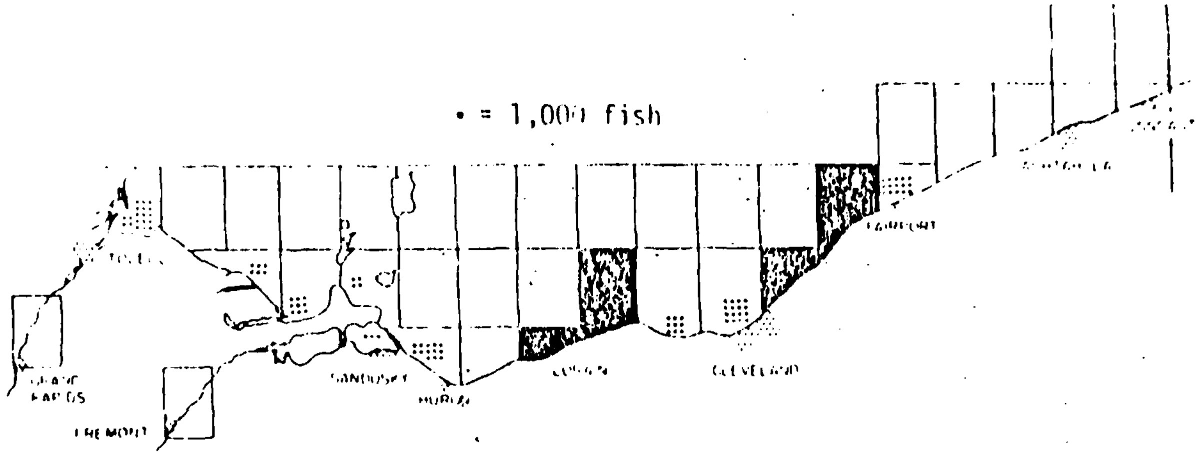


Yellow perch shore angler grid harvest 1975-1977.

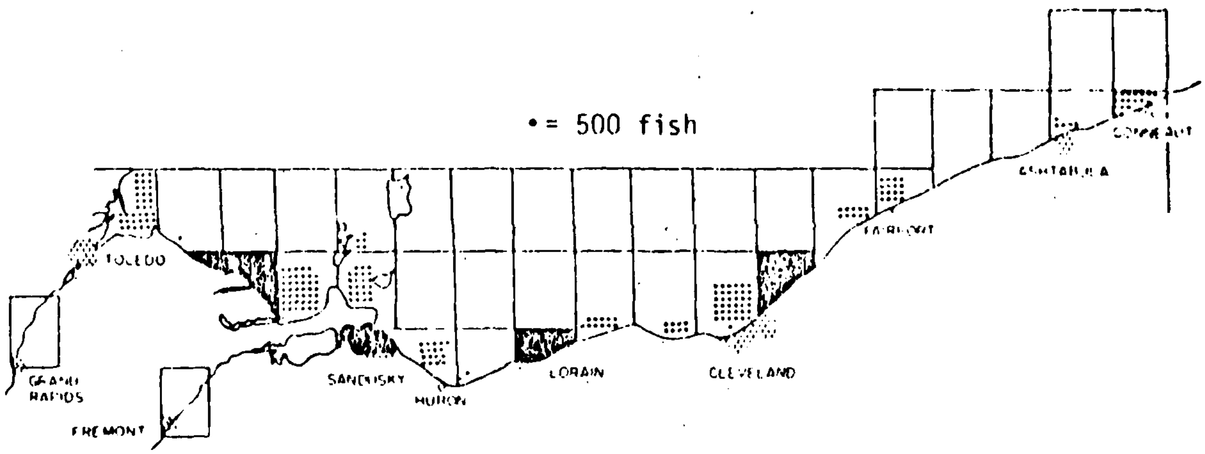


Walleye shore angler grid harvest 1975-1977.

Figure 23. Lake Erie shore angler grid harvest (continued)



White bass shore angler grid harvest 1975-1977.



Other species shore angler grid harvest 1975-1977.

Figure 23. Lake Erie shore angler grid harvest (continued)

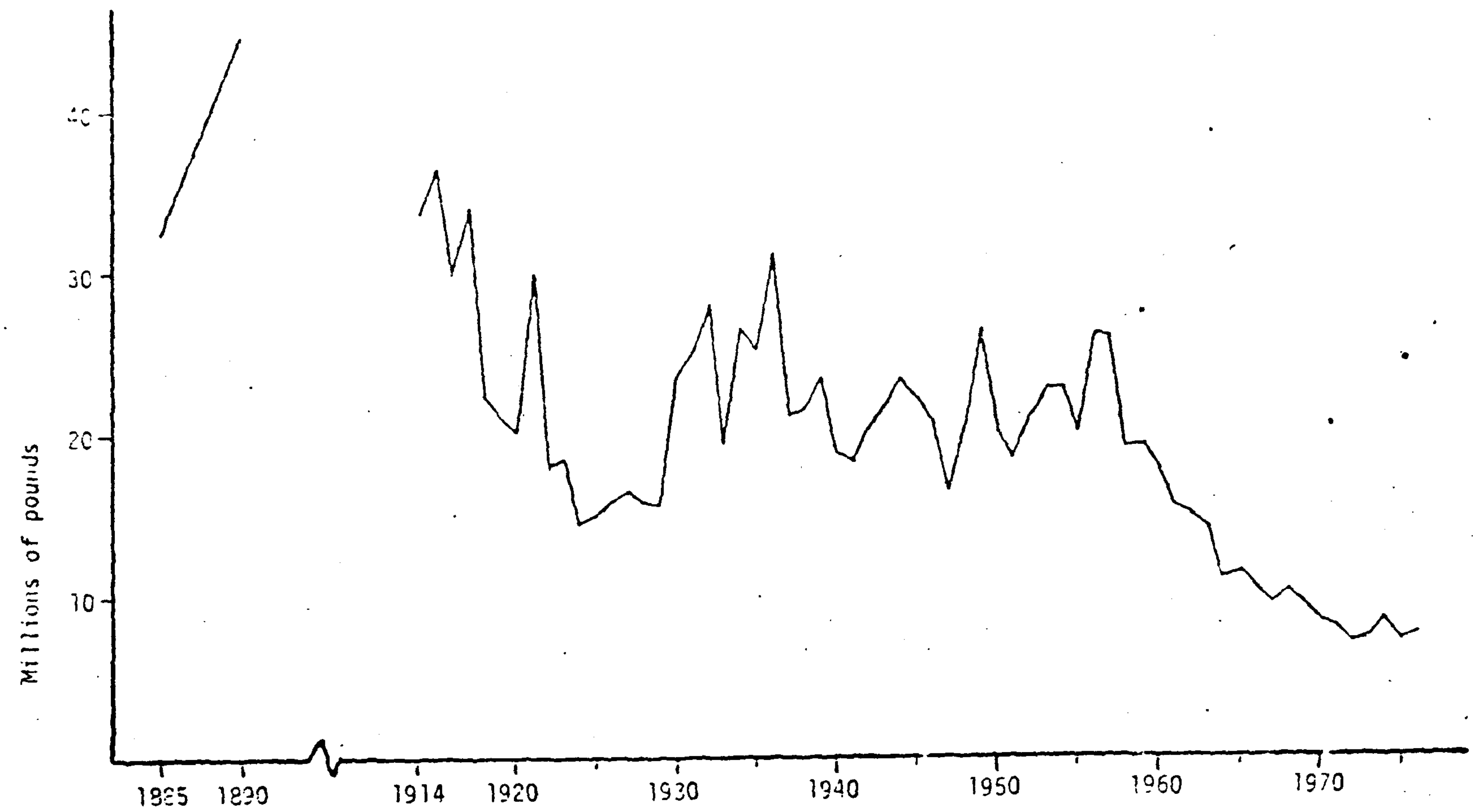


Figure 24. Total commercial production of all species from Ohio waters of Lake Erie, 1885, 1890 and 1914 to 1976.

Table 1. The major wetlands on the southwestern Lake Erie area.

1.** Maumee Bay State Park
2. Cedar Point Marsh, Ottawa National Wildlife Refuge
3. Metzger Marsh State Wildlife Area
4. Ottawa Division Marsh, Ottawa National Wildlife Refuge
5. Magee Marsh State Wildlife Area & Crane Creek Wildlife Experiment Station
6. Navarre Marsh, Ottawa National Wildlife Refuge
7. Toussaint Creek State Wildlife Area
8. Toussaint Shooting Club (private)
9. Darby Marsh, Ottawa National Wildlife Refuge
10. East Harbor State Park
11. Little Portage State Wildlife Area
12. Winous Point Shooting Club (private)*
13. Gypsum Plant Marshes (private)*
14. Meadow Brook (private)*
15. Bay Point Marina (private)*
16. Bay Point (private)*
17. Ottawa Shooting Club (private)*
18. Willow Creek State Wildlife Area*
19. Bay View Marshes (private)*
20. Carp Pond, Kelleys Island
21. Terwilliger's Pond, South Bass Island (private)*
22. Haunck's Pond, Middle Bass Island (private)*
23. Fox's Marsh, North Bass Island (private)*

* Not in the study area

** The numbers in the above table coincide with those on the map in Figure 2.

Table 2. Significant Wetlands of the Southwestern Lake Erie Study Area

Name	No. on Figure 2	Location	Area*	Present Use
Federally Managed Wetlands				
Ottawa NWR Complex				
Cedar Point NWR	2	Lucas Co.	2,245 acres	Special public use by permit only.
Ottawa NWR				
Ottawa Division	4	Lucas & Ottawa Cos.	4,683 acres	Environmental education, controlled goose hunting.
Navarre Division	6	Ottawa Co.	591 acres	Special public use.
Darby Division	9	Ottawa Co.	520 acres	Special public use lands leased by Ottawa NWR from Toledo Edison & Cleveland Electric: 135 acres for 25 years, 456 acres for 50 years.
West Sister Island NWR**	--	Ottawa Co.	77 acres	Wilderness area, research, 8 additional acres belong to the U. S. Coast Guard.
State Managed Wetlands				
Maumee Bay State Park (proposed)	1	Lucas Co.	1,241 acres	Proposed use: swimming, camping, golfing, passive recreation.
Metzger Marsh State Wildlife Area	3	Lucas Co.	558 acres	Marina, hunting, fishing, trapping
Magee Marsh State Wildlife Area and Crane Creek Wildlife Experiment Station	5	Ottawa Co.	2,600 acres	Environmental education, research, controlled hunting.
Toussaint Creek State Wildlife Area	7	Ottawa Co.	236 acres	Hunting, fishing, passive recreation.
Little Portage River State Wildlife Area	11	Ottawa Co.	357 acres	Hunting, fishing, boat launch, passive recreation.
East Harbor State Park	10	Ottawa Co.	1,829 acres (848 acres is open water)	
Middle Harbor				Game sanctuary, fishing, restricted boating.
East Harbor				Fishing, boating, controlled hunting, passive recreation, environmental education.
West Harbor				Same as above.
Carp Pond, Kelleys Island State Reserve Park	20	Erie Co.	8 acres	Natural area.

Table 2. Significant Wetlands of the Southwestern Lake Erie Study Area (continued)

Name	No. on Figure 2	Location	Area	Present Use
Privately Owned Wetlands				
Terwilliger's Pond	21	Ottawa Co.	2-3 acres	Natural education area.
Haunck's Pond	22	Ottawa Co.	5 acres	Natural area.
Fox's Marsh	23	Ottawa Co.	10 acres	Natural area.
Winous Point Shooting Club Marsh	12	Ottawa Co.	3,000 acres	Private hunting area, research.
Ottawa Shooting Club Marsh	17	Ottawa Co.	3,000 acres	Private hunting area.
Toussaint Shooting Club	8	Ottawa Co.	1,480 acres	Private hunting area.

* Many figures include upland acreages as well as wetland acreages

** Not a wetland area

Table 3. Common Aquatic Plants of Lake Erie Wetlands

Common Name	Scientific Name
Shrub-swamp species	
Swamp loosestrife	Decodon vertieillatus
Willow*	Salis sp.
Cottonwood*	Populus deltoides
Buttonbush*	Cephalanthus occidentalis
Narrow-leaved emergents	
Broad-leaved cattail	Typha augustifolia
Narrow-leaved cattail	Typha latifolia
Burreed	Sparganium sp.
Marsh mallow	Hibiscus sp.
River bulrush	Scirpus fluviatilis
Softstem bulrush	Scirpus validus
Broad-leaved emergents	
Pickerelweed	Pontederia cordata
Arrowhead	Sagittaria latifolia
Swamp smartweed	Polygonum coccineum
Moist soil-mudflat species	
Blue-joint grass	Calamagrostis canadensis
Rice cutgrass	Leersia oryzoides
Reed canary grass*	Pharlaris arundinacea
Nodding smartweed	Polygonum lapathifolium
Walter's millet	Echinochloa walteri
Chufa	Cyperus sp.
Floating-leaved species	
Yellow waterlily or spadderdock	Nuphar advena
White waterlily	Nymphea odorata
Lotus	Nelumbo lutea
Floating species	
Lesser duckweed	Lemna minor
Big duckweed	Spirodela polyrhiza
Watermeal	Wolffia sp.
Submergents	
Coontail	Ceratophyllum demersum
Bladderwort	Utricularia vulgaris
Sago pondweed	Potamogeton pectinatus
Water milfoil	Myriophyllum sp.

* Not a true aquatic plant

Table 4. Water Regime Tolerances of Common Aquatic Plants of the Lake Erie Marshes

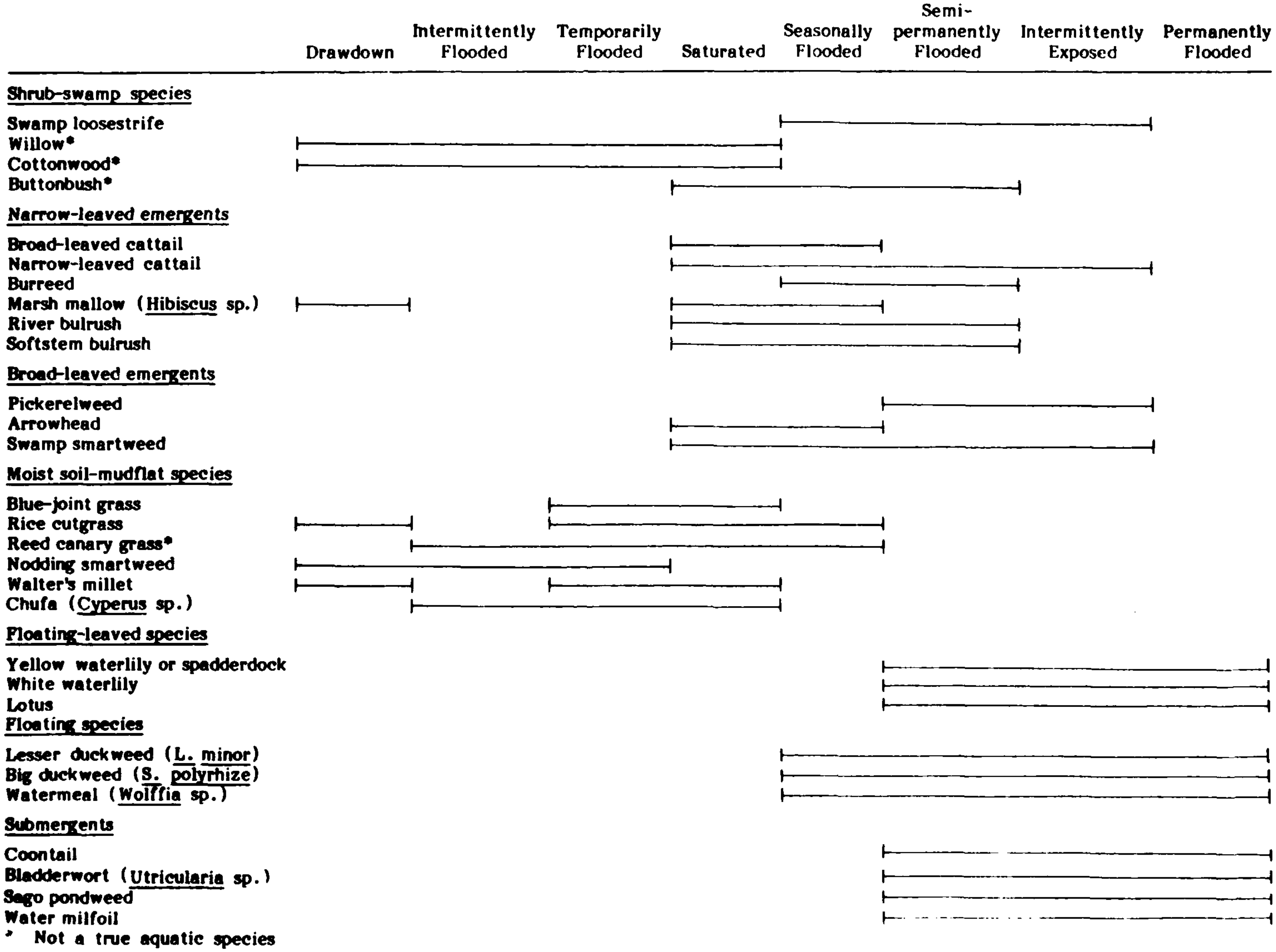


Table 5. Common trees, shrubs, vines, and herbaceous species of the forest association/1

Trees and Shrubs
- Acer negundo (boxelder)
- A. saccharinum (silver maple)
- A. saccharum (sugar maple)
- Carya ovata (shagbark hickory)
- Celtis occidentalis (hackberry)
- Fraxinus americana (white ash)
- F. pennsylvanica (green ash)
- F. quadrangulata (blue ash)
- Gleditsia triancanthos (honey locust)
- Gymnocladus dioica (Kentucky coffee tree)
- Juglans nigra (black walnut)
- Juniperus virginiana (red cedar)
- Morus alba (white mulberry)
- M. ruba (red mulberry)
- Ostrya virginiana (hop-hornbeam)
- Prunus serotina (black cherry)
- P. virginiana (choke cherry)
- Ptelea trifoliata (hop-tree)
- Quercus alba (white oak)
- Q. bicolor (swamp white oak)
- Q. coccinea (scarlet oak)
- Q. macrocarpa (bur oak)
- Q. muehlenbergii (chinquapin oak)
- Q. rubra (red oak)
- Ribes americanum (black currant)
- R. cynosbati (wild gooseberry)
- Staphylea trifolia (bladdernut)
- Tilia americana (basswood)
- Ulmus americana (American elm)
- U. rubra (slippery elm)

Vines
- Celastrus scandens (bittersweet)
- Humulus lupulus (hops)
- Menispermum canadense (moonseed)
- Parthenocissus quinquefolia vitacea (Virginia creeper)
- Rhus radicans (poison ivy)
- Sicyos angulatus (bur cucumber)
- Smilax rotundifolia (greenbriar)
- Vitis riparia (riverbank grape)

Herbaceous Species
- Alliaria officinalis (wild garlic)
- Allium cernuum (wild leek)
- S. tricoccuum (wild nodding onion)
- Arabis laevigata (rock cress)
- Arisaema atrorubens (Jack-in-the-pulpit)
- Campanula americana (bellflower)
- Camassia scilloides (wild hyacinth)
- Carex blanda (sedge)
- Circaea quadrisulcata (nightshade)
- Geranium robertianum (wild geranium)
- Hydrophyllum appendiculatum (water-leaf)
- Hystrix patula (bottlebush grass)
- Osmorhiya longistylis (sweet Cicely)
- Phlox divaricata (sweet William)
- Phryma leptostachya (lopseed)
- Smilacina racemosa (false Solomon seal)
- S. stellata
- Trillium grandiflorum (trillium)
- Urtica procera (nettle)
- Viola pubescens (violet)

/1 From Stuckey and Duncan (1977) and Cooper and Herdendorf (1977)

Table 6. Species of shoreline cliffs and low bedrock shores on Lake Erie islands/1

<u>Lichens</u>
- Biatorella
- Teloschistea
- Dermatocarpon
- Psora

<u>Mosses</u>
- Ambylstegium
- Brachythecium
- Fissidens
- Grimmia
- Gymnostomum
- Tortella
- Tortula

<u>Aerial Algae</u>
- Trentepohlia

<u>Herbaceous Species Tops of High Cliffs</u>
- Achillea millefolium
- Allium cernuum (wild leek)
- Andropogon gerardii (turkey foot)
- Arabis pycnocarpa (rock cress)
- A. drummondii (rock cress)
- Arenaria stricta (sandwort)
- Aquilegia canadensis (columbine)
- Asplenium trichomanes (spleenwort)
- Aster pilosus (wild aster)
- Campanula rotundifolia (harebell)

<u>Herbaceous Species Tops of High Cliffs</u> continued
- Carex eburnea (sedge)
- Cerastium arvense (chickweed)
- Elymus canadensis (wild rye)
- Fragaria vesca (wild strawberry)
- Geranium robertianum (wild geranium)
- Heuchera americana (alum-root)
- Houstonia nigricans
- Panicum lanuginosum (panic grass)
- Pellea glabella (cliff-brake fern)
- Penstemon hirsutus (beard tongue)
- Prenathes alba (white lettuce)
- Prunella vulgaris (self-heal)
- Scutellaria parvula (scullcap)
- Sedum sarmentosum (stonecrop)
- Solidago memoralis (goldenrod)
- Sphenopholis intermedia (wedge-grass)
- Viola neprophylla (violet)

<u>Base of Cliffs and Low Bedrock Shores</u>
- Aster pilosus (wild aster)
- Boltonia asteroides
- Carex granularis (sedge)
- Geranium robertianum (wild geranium)
- Juncus dudleyi (rush)
- J. tenuis (rush)
- Lobelia kalmii
- Lysimachia quadriflora (loosestrife)
- Lythrum alatum (loosestrife)

/1 From Stuckey and Duncan (1977) and Cooper and Herdendorf (1977)

Table 6. Species of shoreline cliffs and low bedrock shores on Lake Erie islands [1] (continued)

Herbaceous Species
Base of Cliffs and Low Bedrock Shores continued
- Panicum lanuginosum (panic grass)
- Panicum virgatum (panic grass)
- Penstemon hirsutus (beard tongue)
- Poa compressa (Canada bluegrass)
- Prunella vulgaris (self-heal)
- Pycnanthemum virginianum (mint)
- Senecio pauperculus (ragwort)
- Solidago graminifolia (goldenrod)
- Sphenopholis intermedia

Woody Species
- Amelanchier sanguinea (service-berry)
- A. spicata (service-berry)
- Cornus drummondii (dogwood)
- C. obliqua (dogwood)
- Juniperus virginiana (red cedar)
- Lonicara dioica (wild honeysuckle)
- L. morrowi (wild honeysuckle)
- Ostrya virginiana (hop-hornbeam)
- Parthenocissus inserta (Virginia creeper)
- Physocarpus opulifolius (ninebark)
- Prunus virginiana (choke cherry)
- Ptelea trifoliata (hop-tree)
- Rhus radicans (poison ivy)
- R. typhina (staghorn sumac)
- Salix bebbiana (willow)
- S. discolor (willow)

Woody Species continued
- S. interior (willow)
- Solanum dulcamara (bittersweet)
- Taxus canadensis (American yew)
- Vitis riparia (riverbank grass)

/1 From Core (1948), Stuckey and Duncan (1977) and Cooper and Herdendorf (1977)

Table 7. Distinctive species of sandy shores on Lake Erie islands/1

Herbaceous Species

Asclepis syriana (milkweed)
Broms tectorum (downy chess)
Cakile edentula (sea rocket)
Cenchurus longispinus (fern)
Cycoloma atriplicifolia (pigweed)
Elymus canadensis (wild rye)
E. virginicus (wild rye)
Euphoribia polygonifolia (spurge)
Mirabilis nyctaginea (four o'clock)
Oenothera biennis (evening primrose)
Panicum virgatum (panic grass)
Physalis heterophylla (ground cherry)
Polanisia dodecandra (clammy weed)
Salsola kali
Strophostyles helvola (wild bean)
Teucrium canadense (wood sage)
Tripeasis purpurea (sand grass)
Xanthium strumarium (cocklebur)

Woody Species

Campsis radicans (trumpet creeper)
Celastrus scandens (bittersweet)
Cornus drummondii (dogwood)
C. obliqua (dogwood)
Fraxinus pennsylvanica (green ash)
Parthenocissus quinquefolia (virginia creeper)
Ptelea trifoliata (hop-tree)
Rhus radicans (poison ivy)
Rhus typhina (staghorn sumac)
Salix interior (willow)
Vitis riparia (riverbank grape)

/1 From Stuckey and Duncan (1977) and Cooper and Herdendorf (1977)

Table 8. Distinctive species of gravel beaches and bars on Lake Erie islands[/1]

<u>Herbaceous Species</u>

Asclepias incarnata (milkweed)
Geranium robertianum (wild geranium)
Parietaria pennsylvanica
Polygonum lapathifolium pennsylvanicum
Teucrium canadense (wood sage)

<u>Woody Species</u>

Acer negundo (boxelder)
Celtis occidentalis (hackberry)
Cornus drummondii (dogwood)
C. obliqua (dogwood)
Fraxinus americana (white ash)
F. pennsylvanica (green ash)
Parthenocisus vitacea (Virginia creeper)
Platanus occidentalis (sycamore)
Populus deltoides (cottonwood)
P. tremuloides (quaking aspen)
Rhus radicans (poison ivy)
Salix alba (willow)
S. amygdaloides (willow)
S. fragilis (willow)
Tilia americana (basswood)
Ulmus americana (American elm)
Vitis riparia (riverbank grape)

/1 From Stuckey and Duncan (1977) and Cooper and Herdendorf (1977)

Table 9. Species of the open lake on Lake Erie islands[/1]

Butomus umbellatus f. vallisneriifolius (flowering rush)
Heteranthera dubia (mud-plantain)
Myriophyllum exalbescens
Potamogeton nodosus (pondweed)
P. pectinatus (pondweed)
P. richardsonii (pondweed)
Vallisneria americana (tape-grass)

/1 From Stuckey and Duncan (1977) and Cooper and Herdendorf (1977)

Table 10. Species of the bays on Lake Erie islands/1

Ascleplas incarnata (swamp milkweed)
Butomus umbellatus f. vallisneriifolius (flowering rush)
Carex comosa (sedge)
C. frankii (sedge)
Ceratophyllum demersum (hornwort)
Elodea canadensis
Elodea nuttallii
Heteranthera dubia (mud plantain)
Juncus torreyi (rush)
Justicia americana (water willow)
Myriophyllum exalbenscens
Nelumbo lutea (lotus lily)
Potamogeton crispus (pondweed)
P. filiformis (pondweed)
P. pectinatus (pondweed)
P. pusillus var. tenuissimus (pondweed)
P. richardsonii (pondweed)
Rumex verticillatus (water-dock)
Sagittaria latifolia (arrow-head)
Scirpus acutus (bulrush)
S. americanus (bulrush)
S. atrovirens (bulrush)
S. fluviatilis (bulrush)
S. validus (bulrush)
Sparganium eurycarpum (bur-reed)
Typha angustifolia (cattail)
Typha latifolia (cattail)
Vallisneria americana (tape-grass)
Zannichellia palustris (horned pondweed)

/1 From Stuckey and Duncan (1977) and Cooper and Herdendorf (1977)

Table 11. Number of invertebrate species in major taxa reported in Lake Erie[1]

Protozoa (unicellular animals)	70
Coelenterata (hydras & jellyfish)	4
Rotatoria	147
Calanoid Copepods	9
Harpaticoid Copepods	1
Cyclopoid Copepods	10
Cladocera (water fleas)	48
Porifera (sponges)	1
Turbellaria (flatworms)	2
Bryozoa (moss animals)	1
Nematoda (roundworms)	1
Tubificidae (sludgeworms)	22
Enchytraeidae	1
Naididae	5
Lumbriculidae	1
Polychaeta	1
Hirudinea (leeches)	16
Sphaeriidae (fingernail clams)	19
Unionidae (mussels)	28
Gastropoda (snails)	24
Tardigrada (waterbears)	1
Hydracarina (water mites)	3
Ostracoda (seed shrimp)	1
Mysidacea (opossum shrimp)	1
Isopoda (aquatic sowbugs)	2
Amphipoda (scuds)	5
Decopoda (shrimp & crayfish)	4
Chironomidae (midges)	29
Other Diptera	3
Neuroptera	1
Hemiptera	4
Plecoptera (stoneflies)	1
Odonata (damsel flies)	2
Trichoptera (caddisflies)	14
Ephemeroptera (mayflies)	15
Coleoptera (beetles)	4
Total species	501
Blank categories	0
No. Research Reports	53

1/ From Great Lakes Basin Commission (1976)

Table 12. Distribution of animals according to depth, type of substratum, and vegetation. Abundance is indicated as follows: x, present; xx numerous; xxx, maximum.[1]

Organism	Depth in inches				Type of substratum							Vegetation	
	1-6	18	36	72	Sand	Gravel	[illegible]	Clay	Flat rubble	[illegible]	[illegible]	Potamogeton	[illegible]
Annelida													
Limnodrilus			x	x	x			x					
Nais	xxx												xxx
Lumbricillus		x											
Placobdella				x				x					
Herpobdella	xxx	xx	x	x		x		x	x	xxx			
Glossiphonia	xxx	x						x		xxx			
Arachnida													
Hydracarinidae	xx	xxx	x	x		x		xx	x	xxx		xx	x
Bryozoa													
Plumatella	x	xx	xxx	x		x			x	xxx	x		
Coelenterata													
Hydra	x	xxx	x	x		x			xx				
Crustacea													
Gammarus	xxx	xx	x	x	x			xx		xxx		xx	xxx
Hyalella	xxx	xx		x	x				x	xxx			x
Cambarus	xxx	x				x		x		x			
Asellus		x								x			
Insecta													
Chironomid larvae	xx	xxx	x	x	x	x	xxx	x	x	xx	xxx	xx	x
Hydroptilidae	xxx	xx	x	x	x	x	x	x	xx	xxx	x	x	
Leptoceridae	xxx	xx	x	x	x	x	x	x	xx	xxx	x	x	
Hydropsyche	xxx	xx	x	x		x	x	x	xxx	xx			
Helicopsyche	xxx	x	xx	x	x	x	x	x	xx	xxx			
Rhyacophilidae	x	xxx	xx	x					x	xx			
Molanna				x		x							
Sericostomatidae		x							x				
Caenis	xx	xxx			x	x	x	x		xxx		x	x
Hexagenia		x							x				
Heptagenia	xx	xxx			x	x	x	x	xx	xxx			
Ameletus	x	x		x	x							x	x
Parnidae adults	xxx	xx	x	x	x			x	x	xxx			
Atherix	x				x								
Corixa	x			x	x								x
Zygoptera				x	x								
Perla	xxx	x								x			
Mollusca													
Amnicola	xx			xxx	xxx				x	x			
Goniobasis	xx	x	x	xxx	x	x	x	x	xx	xxx			
Physa	xxx	xx	x	x	x	x	x	x	xxx	xx			
Pleurocera		x	x	x	x				x	x			
Campeloma		x	x		x					x			
Lymnaea	xxx	xx		x			x	x	x	xxx			

[1] from Hartley and Van Vóoren (1977)

Table 12. Distribution of animals according to depth, type of substratum, and continued vegetation. Abundance is indicated as follows; x, present; xx, numerous; xxx, maximum.

Organism	Depth in inches				Type of substratum							Vegetation	
	1-6	18	36	72	Sand	Gravel	[illegible]	Clay	Flat rubble	[illegible]	[illegible]	Potamogeton	Cladophora
Mollusca													
Planorbis	xxx	x					x		x	x			
Ancylus				x			x						
Segmentina				x						x			
Lampsilis		x			x								
Pisidium				x	x								
Bithynia				x	x								
Porifera													
Spongilla	x	x	xx	xxx			x		xx	xxx			
Turbellaria													
Planaria		xx	xx	x	x	x		x	x	x			

Table 13. Order of yield of the principal commercial species of fish caught in Lake Erie in selected years from 1908 to 1966 [1]

Order of yield	Year							
	1908	1915	1920	1930	1940	1950	1960	1966
1	Cisco	Blue pike	Cisco	Blue pike	Blue pike	Blue pike	Y. perch	Y. perch
2	Blue pike	Cisco	Blue pike	Y. perch	Whitefish	Walleye	Smelt	Smelt
3	Carp	Carp	Carp	Drum	Y. perch	Y. perch	Drum	Carp
4	Walleye	Sauger	Sauger	Whitefish	Walleye	Drum	White bass	Drum
5	N. pike	Whitefish	Y. perch	Carp	Drum	Whitefish	Carp	White bass
6	Sauger	Y. perch	Whitefish	Walleye	Carp	Carp	Walleye	Walleye
7	Y. perch	Walley	Drum	Suckers	Suckers	White bass	C. catfish	C. catfish
8	Whitefish	Drum	Suckers	Sauger	Cisco	C. catfish	Suckers	Suckers
9	Suckers	Suckers	Walleye	Cisco	Sauger	Cisco	Goldfish	Goldfish
10	-	-	C. catfish	White bass	White bass	Suckers	Bullheads	Bullheads

[1] From Applegate and Van Meter (1970)

Table 14. Estimated ranking (biomass) of some major species in the Ohio waters of Lake Erie[1]

Species or group	Rank
Shiners (emerald and spottail combined)	1
Gizzard shad	2
Freshwater drum	3
Yellow perch	4
Carp	5
White bass	6
Goldfish	7
Channel catfish	8
Walleye	9
Suckers (white and redhorses combined)	10
Rainbow smelt	11
Crappies (white and black combined)	12
Bullheads (brown, black and yellow combined)	13
Smallmouth bass	14
Bluegill	15
Largemouth bass	16
Salmon (coho and chinook combined)	17
Sauger	18

1 From Lake Erie Fisheries Unit, Sandusky, Ohio

Table 15. Fish species of the nearshore zone of Lake Erie/1

Scientific Name (Common Name)/2	Category/3	Relative Abundance	Spawning Season and Spawning Water Temperature
Petromyzontidae			
*Ichthyomyzon unicuspis (silver lamprey)	a	Formerly abundant, now decreased	
Petromyzon marinus (sea lamprey)	a	Uncommon	Mid-June - July 11 - 24°C
Acipenseridae			
*Acipenser fulvescens (lake sturgeon)	a	Formerly abundant, now rare	May - June 12 - 19°C
Lepisosteidae			
*Lepistosteus oculatus (spotted gar)	c, d	Formerly uncommon, now rare	Spring
Lepisosteus osseus (longnose gar)	c, d	Numerous but decreasing	Late spring - early summer
Amiidae			
Amia calva (bowfin)	c, d	Numerous locally, possibly decreasing	Spring 16 - 19°C
Clupeidae			
Alosa pseudoharengus (alewife)	a	Abundant	June - July 22°C
Dorosoma cepedianum (gizzard shad)	c, d	Abundant	June - July 19.5°C
Salmonidae			
Coregonus artedii (lake herring or cisco)	a	Formerly abundant, now rare	November - December 1.1 -5.0°C
Coregonus clupeaformis (lake whitefish)	a	Formerly abundant, now rare	November - December 8°C
Oncorhynchus kisutch (coho salmon)	a	Common	September - October

Table 15. Fish species of the nearshore zone of Lake Erie[1] (continued)

Scientific Name (Common Name)[2]	Category[3]	Relative Abundance	Spawning Season and Spawning Water Temperature
Oncorhynchus gorbuscha (pink salmon)	a	Recently introduced, first recorded 1979	Mid-July-late October 10^{o}-16^{o}C
Oncorhynchus nerka (kokanee salmon)	a	Rare, probably absent	November - December
Oncorhynchus tshawytscha (chinook salmon)	a	Common	
Salmo gairdneri (rainbow trout)	a	Common	Spring 10.0 -15.5^{o}C
Salmo salar (Atlantic salmon)	a	Probably absent	October - November
Salvelinus namaycush (lake trout)	a	Formerly common, now rare, but possibly increasing	September - November 1.1 to 5.0^{o}C
Osmeridae			
Osmerus mordax (rainbow smelt)	a	Abundant	May 10^{o}C
Hiodontidae			
*Hiodon tergisus (mooneye)	c, d	Rare	Late spring to early summer
Umbridae			
Umbra limi (central mudminnow)	c, d	Common but decreasing	Early spring 13^{o}C
Esocidae			
Esox americanus vermiculatus (grass pickerel)	c, d	Once numerous locally, now decreased	Late March - early May 7 to 12^{o}C
Esox lucius (northern pike)	c, d	Common locally, but greatly decreased from original abundance	February - March 8^{o}C
*Esox masquinongy (muskellunge)	c, d	Rare	April 4.5 to 10^{o}C

Table 15. Fish species of the nearshore zone of Lake Erie/1 (continued)

Scientific Name (Common Name)/2	Category/3	Relative Abundance	Spawning Season and Spawning Water Temperature
Esox niger (chain pickerel)	c	Introduced locally, probably absent	April - May 8 to 10°C
Cyprinidae			
Carassius auratus (goldfish)	c, d	Abundant	Late spring
Cyprinus carpio (carp)	c, d	Abundant	April - June 25.2°C
*Hybopsis storeriana (silver chub)	b, c, d	Formerly rare, now increasing	June 21°C
Notemigonus crysoleucas (golden shiner)	c, d	Greatly reduced from original abundance but still common locally	May - August 16 - 27°C
Notropis anagenus (pugnose shiner)	c, d	Rare	
Notropis atherinoides (emerald shiner)	c, d	Abundant	June - August 23 °C
*Notropis emiliae (pugnose minnow)	c, d	Rare, possibly extirpated	
Notropis heterodon (blackchin shiner)	c, d	Rare	May - June
*Notropis heterolepis (blacknose shiner)	c, d	Rare, possibly extirpated	Spring-summer
Notropis hudsonius (spottail shiner)	c, d	Abundant	
Notropis spilopterus (spotfin shiner)	c, d	Common	June - late August
Notropis stramineus (sand shiner)	c, d	Common locally	
Notropis volucellus (mimic shiner)	c, d	Numerous locally	

Table 15. Fish species of the nearshore zone of Lake Erie[1] (continued)

Scientific Name (Common Name)[2]	Category[3]	Relative Abundance	Spawning Season and Spawning Water Temperature
Pimephales notatus (bluntnose minnow)	c, d	Comn on	April - September 21°C
Pimephales promelas (fathead minnow)	c, d	Common locally	May - August 15.6°C
Rhinichthys cataractae (longnose dace)	c, d	Common locally, decreasing	April- May 12°C
Castostomidae			
Carpiodes cyprinus (quillback)	c, d	Common	April - May
Catostomus catostomus (longnose sucker)	b	Locally common, decreasing	April - May 5°C
Catostomus commersoni (white sucker)	c, d	Abundant	March - April 10°C
*Erimyzon sucetta (lake chubsucker)	c, d	Uncommon	March - April
Ictiobus cyprinellus (bigmouth buffalo)	c, d	Common locally	Mid-May - early June 15.5 - 18°C
Minytrema melanops (spotted sucker)	c, d	Uncommon, decreasing	Late spring - ea ly summer 15 - 18°C
Moxostoma anisurum (silver redhorse)	c, d	Common but decreasing	Spring 13°C
Moxostoma erythrurum (golden redhorse)	c	Occasional	Spring 15°C
Moxostoma macrolepidotum (shorthead redhorse)	c, d	Common	Spring 11°C
Ictaluridae			
Ictalurus catus (white catfish)	c, d	Probably absent	

Fish species of the nearshore zone of Lake Erie[1] (continued)

Scientific Name (Common Name)[2]	Category[3]	Relative Abundance	Spawning Season and Spawning Water Temperature
Ictalurus melas (black bullhead)	c, d	Numerous	May - June 15.6 -23.9°C
Ictalurus natalis (yellow bullhead)	c, d	Formerly common, now decreased	May - June 15.6 - 23.9°C
Ictalurus nebulosus (brown bullhead)	c, d	Numerous	May - June 15.6 - 23.9°C
Ictalurus punctatus (channel catfish)	c, d	Common	April - August 27°C
Noturus flavus (stonecat)	c, d	Common	Summer 28°C
Noturus gyrinus (tadpole madtom)	c, d	Formerly numerous, decreasing	Late June - July
Noturus minurus (brindled madtom)	c, d	Formerly numerous, now decreased	July - early August 26°C
Pylodictis olivaris (flathead catfish)	c	Occasional	
Anguillidae			
Anguilla rostrata (American eel)	c, d	Occasional	Spawn at sea in autumn
Cyprinodontidae			
**Fundulus diaphanus* (banded killifish)	c, d	Rare	
Gadidae			
**Lota lota* (burbot)	b	Common locally	November - May 0.6 - 1.7°C
Percidae			
**Ammocrypta pellucida* (eastern sand darter)		Rare, possibly extirpated	

Table 15. Fish species of the nearshore zone of Lake Erie[/1] (continued)

Scientific Name (Common Name)[/2]	Category[/3]	Relative Abundance	Spawning Season and Spawning Water Temperature
Etheostoma blennioides (greenside darter)	c, d	Formerly abundant locally, now decreased	Spring
*Etheostoma exile (Iowa darter)	c, d	Formerly common, now present locally but uncommon	Spring
Etheostoma flabellare (fantail darter)	c, d	Formerly common locally, now decreased	Spring
Etheostoma nigrum (johnny darter)	c, d	Common	Spring
Perca flavescens (yellow perch)	a	Abundant	Mid-April - May 16°C
Percina caprodes (logperch)	c, d	Common, now decreased	Late spring
*Percina copelandi (channel darter)	c, d	Formerly abundant, now rare	April -May 8.2°C
Stizostedion canadense (sauger)	a	Rare but increasing	March - May 4.5 - 11.1°C
Stizostedion vitreum (walleye)	a	Common but greatly reduced from former abundance	Spring 5.6 - 11.1°C
Sciaenidae			
Aplodinotus grunniens (freshwater drum)	a	Abundant	Spring 21°C
Cottidae			
Cottus bairdi (mottled sculpin)	c, d	Common	Spring
Gasterosteidae			
Culaea inconstans (brook stickleback)	c, d	Formerly common, now greatly reduced	Late April - July 8 - 19°C

Table 15. Fish species of the nearshore zone of Lake Erie[1] (continued)

Scientific Name (Common Name)[2]	Category[3]	Relative Abundance	Spawning Season and Spawning Water Temperature
Percopsidae			
Percopsis omiscomaycus (trout-perch)	b, c, d	Formerly abundant, decreased to common	Late April - July 10°C
Percichthyidae			
Morone americana (white perch)	c, d	Uncommon but increasing	May - June 11 - 15°C
Morone chrysops (white bass)	a	Abundant	April - May 19°C
Centrarchidae			
Ambloplites rupestris (rock bass)	c, d	Formerly abundant, still common locally	Late spring - early summer 15 - 21°C
Lepomis cyanellus (green sunfish)	c, d	Common locally	May - August 20 - 28°C
Lepomis gibbosus (pumpkinseed)	c, d	Common locally but decreasing	April - May 18 - 21°C
Lepomis macrochirus (bluegill)	c, d	Formerly abundant, still common	May - August
Micropterus dolomieui (smallmouth bass)	c, d	Formerly abundant, now locally	May - July 13 - 18°C
Micropterus salmoides (largemouth bass)	c, d	Formerly abundant, now common locally	May - July 18 - 22°C
Pomoxis annularis (white crappie)	c, d	Common to abundant locally	May - June 18°C
Pomoxis nigromaculatus (black crappie)	c, d	Common locally	March - May 14 -18°C
Atherinidae			
Labidesthes sicculus (brook silverside)	c, d	Formerly abundant, greatly decreased	Spring - early summer

Table 15. Fish species of the nearshore zone of Lake Erie/1 (continued)

/1 Based on Trautman (1957), Van Meter and Trautman (1970), and Scott and Crossman (1973)

/2 According to Bailey et al. (1970)

/3 Categories based on relative utilization of nearshore zone: (Barnes, 1979)

(a) highly mobile, migratory populations which concentrate randomly or seasonally in the nearshore zone,

(b) populations centered in offshore waters with frequent entry into nearshore zone,

(c) populations centered in inland waters with frequent entry into nearshore zone,

(d) populations centered in nearshore zone.

* Ohio endangered species.

Table 16. Past and present salmonid planting sites in western Lake Erie

Ohio/1	
Huron River	Coho, chinook
Cold Creek	Atlantic salmon (not since 1932), chinook, coho, brown trout, steelhead.
*Pickerel Creek	Coho, chinook
*Sandusky River	Atlantic, chinook
*Portage River	Atlantic, chinook
*Maumee River	Atlantic, chinook
Michigan/2	
*Raisin River	Atlantic, chinook
Huron River	Atlantic, chinook, sockeye (not since 1970)

* Inactive sites

/1 Based on Parsons (1973), Ohio Department of Natural Resources (1975, 1976, 1977, 1978).

/2 Based on Michigan Department of Natural Resources (1979).

Table 17. Age composition of channel catfish taken in Ohio Division of Wildlife net run commercial samples, 1978.

Location, Gear, Date	No. of Fish		Year Classes 1976	1975	1974	1973	1972	1971	1970	1969	1968	1967	1966	Percent Female	Mean Length (mm.)	Mean Age	Percent Legal
Sandusky Bay, Seine 27 April	150	%	--	--	--	7	15	39	20	16	1	1	1				
		Avg. mm.	--	--	--	335	357	383	410	453	516	549	621				
		% female	--	--	--	40	52	45	53	46	100	100	100	49%	399	7.36	52%
Sandusky Bay, Seine 5 May	150	%	--	--	--	11	17	38	18	9	6	1	--				
		Avg. mm.	--	--	--	324	348	381	404	454	505	544	--				
		% female	--	--	--	41	54	54	44	15	25	50	--	46%	388	7.17	40%
Port Clinton, Seine 10 May	150	%	3	3	1	17	13	26	23	10	3	1	--				
		Avg. mm.	206	261	309	326	345	378	408	439	479	550	--				
		% female	60	20	50	62	50	58	56	40	25	100	--	53%	371	6.71	37%
Bono, Trap Net 13 May	159	%	--	9	12	28	12	18	9	6	3	2	1				
		Avg. mm.	--	246	286	319	349	381	414	452	489	562	675				
		% female	--	64	32	30	74	55	53	33	60	33	0	46%	354	6.06	26%
Port Clinton, Seine 23 May	150	%	--	4	3	30	17	24	12	8	1	1	--				
		Avg. mm.	--	235	305	330	344	375	418	451	471	506	--				
		% female	--	83	25	62	73	64	50	55	100	100	--	63%	362	6.35	29%

Table 18. Channel catfish grid harvest by numbers.

	Grid	Shore 1975	Shore 1976	Shore 1977	Shore Total	Boat 1975	Boat 1976	Boat 1977	Boat Total	Grand Total
Winter	802	0	0	0	0					0
	901	0	0	0	0					0
	904	0	0	0	0					0
	905	0	0	0	0					0
	1004	0	0	0	0					0
	1005	0	0	0	0					0
Subtotal		0	0	0	0					0
Spring River	800	4,437	7,196	11,900	23,533					23,533
	1003	608	1,976	2,721	5,305					5,305
Subtotal		5,045	9,172	14,621	28,[illegible]					28,838
Summer District I	801	1,498	4,158	8,726	16,382	2,731	2,350	1,467	6,548	22,930
	802	74	*	*	74	6,301	930	3,199	10,430	10,504
	803	*	*	*	*	63	3,329	2,856	6,248	6,248
	804	*	*	*	*	1,955	23,897	3,956	29,808	29,808
	805	633	*	*	633	2,295	8,479	1,443	12,217	12,850
	806	*	*	*	*	0	154	0	154	154
	903	1,257	2,124	1,786	4,167	35,981	20,737	31,534	88,252	92,419
	904	9,812	9,571	6,336	25,719	62,815	24,318	22,698	109,831	135,550
	905	837	1,925	662	3,424	4,616	19,322	22,786	46,724	50,148
	906	*	*	*	*	0	354	411	765	765
	1006	143	318	168	629	205	2,472	1,697	4,374	5,003
		16,254	18,096	16,678	51,028	116,962	106,342	92,047	315,351	366,379
District II	612	*	*	*	*	0	0	0	0	0
	613	256	137	78	471	6,764	15,280	3,441	25,485	25,956
	907	*	*	*	*	0	0	0	0	0
	908	*	*	*	*	252	54	0	306	306
	909	330	329	341	1,000	36,211	11,531	8,471	56,213	57,213
	910	893	200	76	1,169	348	146	341	835	2,004
	911	1,645	726	183	2,554	2,407	0	0	2,407	4,[illegible]
	912	1,399	424	659	2,482	0	0	186	186	2,[illegible]
	1007	345	0	13	358	1,073	1,908	2,509	5,490	5,[illegible]
	1008	3,612	653	895	5,160	7,365	2,007	1,515	10,887	16,047
		8,480	2,469	2,245	13,194	54,420	30,926	16,463	101,809	115,[illegible]
District III	714	*	*	*	*	0	0	0	0	0
	715	*	*	*	*	0	0	0	0	0
	716	*	*	*	*	0	0	0	0	0
	717	47	41	20	108	981	710	1,072	2,763	2,871
	718	91	19	45	155	334	911	0	1,245	1,400
	814	2,041	551	179	2,771	1,625	0	0	1,625	4,396
		2,179	611	244	3,034	2,940	1,621	1,072	5,633	8,667
District IV	1004	*	*	*	*	1,129	10,417	725	12,271	12,271
	1005	1,060	4,067	3,168	10,295	12,931	56,441	22,989	92,361	102,656
		1,060	4,067	3,168	10,295	14,060	66,858	23,714	104,632	114,927
Subtotal		29,973	25,243	22,335	77,551	188,382	205,747	133,296	527,425	604,976
Charter	801					0	0	0	0	0
	802					0	0	0	0	0
	803					61	9	53	123	123
	804					295	181	455	931	931
	805					601	43	138	782	782
	806					405	6	25	436	436
	903					169	42	21	232	232
	904					287	124	210	621	621
	905					176	151	55	382	382
	706					0	0	19	19	19
	1006					90	7	14	111	111
	1005					29	38	0	67	67
	911					10	0	0	10	10
						2,123	601	990	3,714	3,714
Charter**	703-C					0	0	0	0	0
	704-C					0	0	0	0	0
	705-C					0	0	0	0	0
	706-C					0	0	0	0	0
	803-C					0	0	0	0	0
	804-C					0	46	34	80	80
	805-C					0	309	102	411	411
	806-C					0	151	10	161	161
						0	506	146	652	652
Subtotal						2,123	1,107	1,136	4,366	4,366
GRAND TOTAL		35,018	34,415	36,956	106,389	190,305	206,854	134,432	531,791	638,180

* No survey [illegible]

** [illegible] waters

Table 19. White bass grid harvest by numbers.

		SHORE 1975	SHORE 1976	SHORE 1977	SHORE TOTAL	BOAT 1975	BOAT 1976	BOAT 1977	BOAT TOTAL	GRAND TOTAL
Winter	802	0	0	0	0					0
	903	0	0	0	0					0
	904	0	5	0	5					5
	905	0	0	0	0					
	1004	0	0	0	0					0
	1005	0	0	0	0					0
Subtotal		0	5	0	5					5
Spring River	800	36,730	124,235	79,995	240,960					240,960
	1003	133,763	168,813	191,706	494,282					494,282
Subtotal		170,493	293,048	271,701	735,242					735,242
Summer										
District I	801	3,864	10,569	10,599	25,032	0	0	342	342	25,374
	802	116	*	*	116	3,901	60	106	4,067	4,183
	803	*	*	*	*	0	40	1,899	1,939	1,939
	804	*	*	*	*	3,900	18,694	7,033	29,627	29,627
	805	0	*	*	0	8,154	10,692	2,696	21,542	21,542
	806	*	*	*	*	0	284	345	629	629
	903	4,793	1,213	981	6,987	13,858	22,093	5,467	41,418	48,405
	904	6,963	1,093	947	9,003	27,874	13,224	9,362	50,460	59,463
	905	2,670	445	1,551	4,666	91,538	77,151	51,066	219,641	224,307
	906	*	*	*	*	12,099	7	137	12,243	12,243
	1006	7,296	1,379	4,413	13,088	10,727	21,288	6,168	38,183	51,271
		25,702	14,699	18,491	58,892	172,051	163,735	84,575	420,361	479,253
District II	812	*	*	*	*	0	0	0	0	0
	813	27,136	10,421	67,618	105,175	172,946	78,853	225,595	477,394	582,569
	907	*	*	*	*	0	0	0	0	0
	908	*	*	*	*	1,639	0	0	1,639	1,639
	909	481	36,831	117,428	154,740	812,703	280,393	494,194	1,587,290	1,742,030
	910	7,276	513	1,881	9,670	6,905	13,897	72	20,874	30,544
	911	11,035	4,019	1,157	16,211	10,460	4,277	55	14,792	31,003
	912	48,976	66,234	25,463	140,673	6,832	1,838	0	8,670	149,343
	1007	1,287	0	408	1,695	11,294	1,287	7,553	20,134	21,829
	1008	144,890	36,571	118,395	299,856	140,966	42,196	20,212	203,374	503,230
		241,081	154,589	332,350	728,020	1,163,745	422,741	747,681	2,334,167	3,062,187
District III	714	*	*	*	*	0	0	0	0	0
	715	*	*	*	*	0	0	0	0	0
	716	*	*	*	*	0	0	0	0	0
	717	369	174	41	604	116,425	21,663	29,375	167,463	168,067
	718	684	19	75	778	22,780	3,347	793	26,920	27,698
	814	8,810	652	5,847	15,309	28,044	0	6,484	34,528	49,837
		9,863	845	5,963	16,691	167,249	25,010	36,652	228,911	245,602
District IV	1004	*	*	*	*	189	6,123	0	6,312	6,312
	1005	12,529	3,312	1,674	17,515	3,230	30,758	1,227	35,215	52,730
		12,529	3,312	1,674	17,515	3,419	36,881	1,227	41,527	59,042
Subtotal		289,195	173,445	358,478	821,118	1,506,464	648,367	870,135	3,024,966	3,846,084
Charter	801					0	0	0	0	0
	802					0	0	0	0	0
	803					1,481	141	216	1,838	1,838
	804					5,161	1,123	1,073	7,357	7,357
	805					8,112	820	1,156	10,088	10,088
	806					3,732	0	13	3,745	3,745
	903					4,858	39	2,983	7,880	7,880
	904					6,301	2,572	2,346	11,219	11,219
	905					5,121	978	1,219	7,318	7,318
	906					0	13	0	13	13
	1006					2,603	12	0	2,615	2,615
	1005					4,645	74	47	4,766	4,766
	911					281	0	0	281	281
						42,295	5,772	9,053	57,120	57,120
Charter**	703-C					0	0	0	0	0
	704-C					0	0	0	0	0
	705-C					0	0	0	0	0
	706-C					0	0	0	0	0
	803-C					0	0	0	0	0
	804-C					0	63	0	63	63
	805-C					0	236	8	244	244
	806-C					0	194	0	194	194
						0	493	8	501	501
Subtotal						42,295	6,265	9,061	57,621	57,621
GRAND TOTAL		459,688	466,498	630,179	1,556,365	1,548,759	654,632	879,196	3,082,587	4,638,952

*No census location in grid
**Canadian waters.

Table 20. Age composition of white bass taken in Ohio Division of Wildlife net run commercial samples, 1978.

Location, Gear, Date	No. of Fish		1978	1977	1976	1975	1974	1973	1972	1971	1970	1969	Percent female	Mean length (mm)	Mean Age	Percent legal
			Year Classes													
Sandusky Bay, Seine 2[illegible] April	135	%	--	--	33	27	24	5	3	7	1	--				
		Avg. mm	--	--	263	300	321	119	161	178	404	--				
		% female	--	--	34	61	61	43	50	89	100	--	51%	[illegible]	[illegible]	[illegible]
Sandusky Bay, Seine 5 May	150	%	--	--	17	17	43	9	6	4	3	1				
		Avg. mm	--	--	269	313	329	354	350	359	389	402				
		% female	--	--	15	72	66	69	78	67	75	100	60%	323	[illegible]	[illegible]
Cedar Point, Trap Net 9 May	152	%	--	--	46	26	16	5	3	2	1	1				
		Avg. mm	--	--	266	310	323	376	334	343	370	348				
		% female	--	--	33	56	64	50	75	67	100	100	48%	295	[illegible]	[illegible]
Bono, Trap Net 10 May	150	%	--	--	48	23	18	2	1	6	*	--				
		Avg. mm	--	--	267	306	324	354	362	359	361	--				
		% female	--	--	29	43	41	67	100	78	100	--	40%	296	3.13	100%
Cedar Point, Trap Net 17 October	176	%	1	95	3	--	1	--	--	--	--	--				
		Avg. mm	170	251	312	--	366	--	--	--	--	--				
		% female	0	44	100	--	100	--	--	--	--	--	45%	252	1.04	[illegible]

Table 21. Smallmouth bass grid harvest by numbers.

		Shore 1975	Shore 1976	Shore 1977	Shore Total	Boat 1975	Boat 1976	Boat 1977	Boat Total	Grand Total
Winter	802	0	0	0	0					0
	903	0	0	0	0					0
	904	0	0	0	0					0
	905	0	0	0	0					0
	1004	0	0	0	0					0
	1005	0	0	0	0					0
Subtotal		0	0	0	0					0
Spring River	800	7	378	111	496					496
	1003	42	197	192	431					431
Subtotal		49	575	303	927					927
Summer District I	801	0	0	0	0	0	0	0	0	0
	802	0	*	*	0	0	0	0	0	0
	803	*	*	*	*	0	0	58	58	58
	804	*	*	*	*	184	7,475	3,605	11,264	11,264
	805	318	*	*	318	6,539	9,105	3,919	19,563	19,881
	806	*	*	*	*	202	2,537	0	2,739	2,739
	903	20	10	0	30	107	811	289	1,207	1,237
	904	253	62	13	328	942	1,539	615	3,096	3,424
	905	509	300	34	843	3,735	5,105	5,161	14,001	14,844
	906	*	*	*	*	84	180	274	538	538
	1006	520	64	7	591	205	55	1,241	1,501	2,092
		1,620	436	54	2,110	11,918	26,807	15,162	53,967	56,077
District II	812	*	*	*	*	0	0	0	0	[illegible]
	813	0	0	0	0	0	238	183	421	421
	907	*	*	*	*	0	0	0	0	0
	908	*	*	*	*	111	0	0	111	111
	909	6	143	88	237	4,153	107	1,085	5,345	5,582
	910	31	0	0	31	0	0	0	0	31
	911	0	0	0	0	0	0	0	0	0
	912	8	69	0	77	0	0	0	0	[illegible]
	1007	1,069	7	26	1,102	2,480	1,284	1,267	5,031	[illegible]
	1008	157	69	366	592	1,714	0	73	1,787	[illegible]
		1,271	288	480	2,039	8,458	1,629	2,608	12,695	14,732
District III	714	*	*	*	*	0	0	0	0	
	715	*	*	*	*	0	0	0	0	0
	716	*	*	*	*	0	0	0	0	0
	717	54	0	10	64	6,218	847	2,691	9,756	9,820
	718	281	182	941	1,404	1,662	814	458	4,934	6,338
	814	48	14	66	128	0	0	0	0	[illegible]
		383	196	1,017	1,596	7,880	1,661	3,149	14,690	16,286
District IV	1004	*	*	*	*	0	0	0	0	0
	1005	283	197	44	524	63	296	0	359	883
		283	197	44	524	63	296	0	359	883
Subtotal		3,557	1,117	1,595	6,269	30,399	30,393	20,919	81,711	87,980
Charter	801					0	0	0	0	0
	802					0	0	0	0	0
	803					8	3	81	92	92
	804					404	303	324	1,031	1,031
	805					3,594	807	1,932	6,333	6,333
	806					360	8	114	482	482
	903					30	1	0	31	31
	904					139	156	19	314	314
	905					800	431	198	1,429	1,429
	906					0	2	0	2	2
	1006					0	0	0	0	0
	1005					6	32	0	38	38
	911					1	0	0	1	1
						5,342	1,743	2,668	9,753	9,753
Charter**	703-C					0	0	0	0	0
	704-C					0	0	23	23	23
	705-C					0	0	0	0	0
	706-C					0	0	0	0	0
	803-C					0	0	0	0	0
	804-C					0	52	2	54	54
	805-C					0	317	442	759	759
	806-C					0	172	5	177	177
						0	541	472	1,013	1,013
Subtotal						5,342	2,284	3,140	10,766	10,766
GRAND TOTAL		3,606	1,697	1,898	7,196	35,741	32,677	24,059	92,477	99,673

*No census location in grid.
**Canadian waters.

Table 22. Age composition of yellow perch taken in Ohio Division of Wildlife net run commercial samples, 1978.

Location, Gear, Date	No. of Fish		Year Classes 1977	1976	1975	1974	1973	1972	1971	1970	Percent Female	Mean Length (mm.)	Mean Age	Percent Legal
Bono, Trap Net 2 May	150	%	--	--	26	51	13	10	<1	--				
		Avg. mm.	--	--	182	[illegible]	195	204	220	--				
		% female	--	--	28	[illegible]	16	7	0	--	28%	193	4.09	25%
Cedar Point, Trap Net 3 May	190	%	--	--	35	46	9	9	--	1				
		Avg. mm.	--	--	207	214	202	229	--	334				
		% female	--	--	63	65	50	38	--	100	58%	212	3.97	59
Lorain, Gill Net 9 May	150	%	--	1	60	32	6	1	--	--				
		Avg. mm.	--	184	221	223	223	215	--	--				
		% female	--	100	84	35	44	50	--	--	65%	221	3.48	[illegible]
Conneaut, Gill Net 16 May	247	%	--	<1	68	27	4	--	<1	--				
		Avg. mm.	--	166	220	226	236	--	272	--				
		% female	--	0	72	38	83	--	0	--	71%	220	3.37	89
Conneaut, Gill Net 4 October	200	%	7	49	40	3	1	--	--	--				
		Avg. mm.	170	222	226	235	251	--	--	--				
		% female	64	56	15	20	0	--	--	--	39%	218	2.41	87
Lorain, Gill Net 12 October	153	%	3	37	44	14	1	--	1	--				
		Avg. mm.	208	222	227	231	257	--	311	--				
		% female	60	58	32	30	0	--	50	--	42%	227	2.78	95
Cedar Point, Trap Net 17 October	150	%	11	14	52	17	3	3	--	--				
		Avg. mm.	197	209	214	222	221	217	--	--				
		% female	75	52	27	31	0	0	--	--	35%	213	2.97	71
Bono, Trap Net 13 November	150	%	--	1	56	29	8	5	1	--				
		Avg. mm.	--	187	204	213	222	225	253	--				
		% female	--	100	71	66	42	13	0	--	64%	209	3.63	64

Table 23. Sport fishery harvest of yellow perch.

Year	Western Basin	Central Basin	Lakewide Total
Numbers			
1975	5,588,700	2,489,250	8,077,950
1976	5,271,250	1,078,275	6,349,525
1977	9,400,775	1,636,050	11,036,825
1978	8,975,500	1,427,100	10,402,600
Kilograms			
1975	503,301	310,781	814,082
1976	443,387	117,976	561,363
1977	860,497	173,012	1,033,509
1978	870,622	138,429	1,009,051

Table 24. Yellow perch grid harvest by numbers.

		SHORE				BOAT				
		1975	1976	1977	TOTAL	1975	1976	1977	TOTAL	GRAND TOTAL
Winter	802	0	0	55,425	55,425					[illegible],425
	903	0	0	22,544	22,544					22,544
	904	11,095	21,995	77,400	110,490					110,490
	905	0	70	60	130					130
	1004	10,958	5,103	1,262	17,323					17,323
	1005	969	12,465	5,702	19,136					19,136
Subtotal		23,022	39,633	162,393	225,048					225,048
Spring River	800	795	473	1,224	2,492					[illegible]
	1003	0	0	392	392					392
Subtotal		795	473	1,616	2,884					2,884
Summer District I	801	13,459	22,753	46,560	82,772	17,076	323,311	252,424	592,811	675,583
	802	4,883	*	*	4,883	996,615	143,268	1,419,472	2,559,355	2,564,238
	803	*	*	*	*	901	342,479	124,397	467,777	467,777
	804	*	*	*	*	18,084	27,618	27,448	73,150	73,150
	805	0	*	*	0	40,351	32,551	20,297	93,199	93,199
	806	*	*	*	*	5,024	714	247	5,985	[illegible],985
	903	38,115	27,909	90,414	156,438	884,822	983,114	1,252,014	3,119,950	3,276,389
	904	54,879	33,123	26,155	114,157	1,455,364	995,015	890,204	3,340,583	3,454,740
	905	13,415	9,685	12,979	36,079	1,390,283	1,534,009	4,336,430	7,260,722	7,296,801
	906	*	*	*	*	2,672	4,455	28,100	35,227	35,227
	1006	111,275	40,666	48,288	200,229	287,441	550,659	672,945	1,511,045	1,711,[illegible]
		236,026	134,136	224,396	594,558	5,098,633	4,937,193	9,023,978	19,059,804	19,654,362
District II	812	*	*	*	*	10,265	0	0	10,265	10,265
	813	4,928	1,500	15,701	22,129	13,845	[illegible]	24,979	42,238	[illegible]
	907	*	*	*	*	20,247	10,957	0	31,204	31,204
	908	*	*	*	*	19,599	6,594	2,505	28,698	28,698
	909	1,730	1,301	1,374	4,405	380,254	63,279	101,387	544,920	549,325
	910	19,337	3,999	10,585	33,921	30,495	34,062	70,319	134,876	168,797
	911	70,919	39,210	58,034	168,163	260,656	143,580	147,648	551,884	720,047
	912	65,649	54,961	49,547	170,157	340,838	126,855	289,481	757,174	927,331
	1007	872	3	0	875	43,824	80,778	142,958	267,560	268,435
	1008	84,402	29,836	54,354	168,592	688,939	302,844	303,282	1,295,065	1,463,657
		247,837	130,810	189,595	568,242	1,808,962	772,363	1,082,559	3,663,884	4,232,126
District III	714	*	*	*	*	0	0	612	612	612
	715	*	*	*	*	0	310	0	310	310
	716	*	*	*	*	0	0	0	0	0
	717	2,523	803	6,285	9,611	149,528	49,569	123,373	322,470	332,[illegible]
	718	12,936	8,428	17,323	38,687	153,986	88,613	92,812	335,411	374,098
	814	59,044	24,129	62,644	145,817	51,906	3,236	60,[illegible]	115,973	261,790
		74,503	33,360	86,252	194,115	355,420	141,728	277,678	774,776	[illegible]
District IV	1004	*	*	*	*	2,139	6,113	1,190	9,412	9,437
	1005	137,822	66,124	56,022	259,968	96,801	127,690	[illegible]	[illegible]	574,[illegible]
		137,822	66,124	56,022	259,968	98,940	133,803	95,381	[illegible],124	[illegible]
Subtotal		696,188	364,430	556,265	1,616,883	7,361,955	5,985,087	10,480,546	23,827,588	25,444,471
Charter	801					0	0	341	341	341
	802					0	0	0	0	0
	803					861	36	254	1,151	[illegible]
	804					2,695	2,488	15,706	20,889	20,889
	805					3,387	6,152	5,000	14,539	14,539
	806					277	237	217	731	[illegible]
	903					511	102	1,255	1,868	[illegible]
	904					10,528	2,766	62,346	75,640	[illegible]
	905					10,859	29,340	58,291	98,590	[illegible]
	906					757	251	603	1,611	[illegible]
	1006					46,031	13,197	8,586	67,814	[illegible]
	1005					11,876	5,980	3,972	21,728	21,728
	911					5,047	0	0	5,047	5,047
						92,829	60,549	156,571	309,949	309,949
Charter **	703-C					0	0	0	0	0
	704-C					0	0	29	29	29
	705-C					0	0	0	0	0
	706-C					0	0	0	0	0
	803-C					0	0	0	0	0
	804-C					0	9	42	51	51
	805-C					0	760	527	1,287	1,287
	806-C					0	335	161	496	496
						0	1,104	759	1,863	1,863
Subtotal						92,829	61,653	157,330	311,812	311,812
GRAND TOTAL		720,005	404,536	720,274	1,844,815	7,454,784	6,046,740	10,637,876	24,139,400	25,[illegible]

*No Census location in grid.
**Canadian waters.

Table 25. Walleye sport fishery in western Lake Erie, 1975-1978.

Fishery	Walleye Catch	Angler Hours	CPAH
River			
1975	25,000	200,000	0.13
1976	16,000	66,000	0.25
1977	19,000	69,000	0.26
1978	32,000	74,000	0.29
Boat			
1975	70,000	581,000	0.12
1976	588,000	1,653,000	0.31
1977	2,058,000	3,325,000	0.59
1978	1,488,000	3,536,000	0.44
Charter			
1975	6,000	15,000	0.43
1976	31,000	31,000	0.99
1977	87,000	91,000	0.96
1978	132,000	123,000	1.07

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Table 26. Walleye grid harvest by numbers.

		SHORE 1975	SHORE 1976	SHORE 1977	SHORE TOTAL	BOAT 1975	BOAT 1976	BOAT 1977	BOAT TOTAL	GRAND TOTAL
Winter	802	0	0	0	0					0
	903	0	0	0	0					0
	904	0	18	25	43					43
	905	0	0	0	0					0
	1004	0	0	0	0					0
	1005	0	0	0	0					0
Subtotal		0	18	25	43					43
Spring River	800	15,472	5,337	7,045	27,854					27,854
	1003	9,726	11,154	11,537	32,417					32,417
Subtotal		25,198	16,491	18,582	60,271					60,271
Summer District I	801	8	0	9	17	0	564	218	782	799
	802	0	*	*	0	165	869	96,736	97,770	97,770
	803	*	*	*	*	0	3,285	197,198	200,483	200,483
	804	*	*	*	*	2,919	72,680	142,252	217,851	217,851
	805	0	*	*	0	2,981	100,566	80,325	183,872	183,872
	806	*	*	*	*	506	3,364	9,906	13,776	13,776
	903	5	38	78	121	51,846	331,650	1,380,429	1,763,925	1,764,046
	904	158	19	179	356	2,635	14,785	58,577	75,997	76,353
	905	53	0	62	115	8,696	52,206	74,715	135,617	135,732
	906	*	*	*	*	394	7,445	9,363	17,202	17,202
	1006	0	0	19	19	0	445	7,748	8,193	8,212
		224	57	347	628	70,142	587,859	2,057,467	2,715,468	2,716,096
District II	812	*	*	*	*	0	0	0	0	0
	813	15	0	18	33	0	0	66	66	99
	907	*	*	*	*	0	0	0	0	0
	908	*	*	*	*	48	0	0	48	48
	909	1	50	126	177	5,797	3,916	9,392	19,105	19,282
	910	0	0	15	15	65	0	59	124	139
	911	7	0	0	7	0	0	0	0	7
	912	215	238	0	453	0	0	0	0	453
	1007	174	0	0	174	2,112	25,595	24,331	52,038	52,212
	1008	494	0	83	577	955	3,960	759	5,674	6,251
		906	288	242	1,436	8,977	33,471	34,607	77,055	78,491
District III	714	*	*	*	*	0	0	0	0	0
	715	*	*	*	*	0	0	0	0	0
	716	*	*	*	*	0	0	0	0	0
	717	0	0	0	0	975	1,507	1,913	4,395	4,395
	718	0	0	5	5	0	398	157	555	560
	814	24	9	36	69	203	0	99	302	371
		24	9	41	74	1,178	1,905	2,169	5,252	5,326
District IV	1004	*	*	*	*	0	0	0	0	0
	1005	82	39	0	121	0	261	129	390	511
		82	39	0	121	0	261	129	390	511
Subtotal		1,236	393	630	2,259	80,297	623,496	2,094,372	2,798,165	2,800,424
Charter	801					0	0	0	0	0
	802					0	0	351	351	351
	803					348	493	25,068	25,909	25,909
	804					722	3,559	18,499	22,780	22,780
	805					3,149	2,526	7,216	12,890	12,890
	806					462	1,506	1,383	3,351	3,351
	903					401	1,511	6,866	8,778	8,778
	904					876	3,697	17,184	21,757	21,757
	905					360	1,628	311	2,299	2,299
	906					0	393	20	413	413
	1006					15	1	1	17	17
	1005					5	9	7	21	21
	911					0	0	0	0	0
						6,337	15,323	76,906	98,566	98,566
Charter**	703-C					0	41	0	41	41
	704-C					0	0	466	466	466
	705-C					0	0	9	9	9
	706-C					0	222	11	233	233
	803-C					0	52	175	227	227
	804-C					0	2,765	1,385	4,150	4,150
	805-C					0	10,111	6,519	16,630	16,630
	806-C					0	1,998	1,312	3,310	3,310
						0	15,189	9,877	25,066	25,066
Subtotal						6,337	30,512	86,783	123,632	123,632
GRAND TOTAL		26,434	16,902	19,237	62,573	86,634	654,008	2,181,155	2,921,797	2,984,370

* No census location in grid.
** Canadian waters.

Table 27. Young-of-the-year and yearling* per trawling hour - western Lake Erie and Sandusky Bay (summer trawling June through August).

Year	Walleye Y.O.Y.	Walleye YR.	Perch Y.O.Y.	Perch YR.	White Bass Y.O.Y.	White Bass YR.	Freshwater Drum	Spottail Shiner	Gizzard Shad	Alewife
1973	15	5	312	116	1,097	4	274	571	9,313	6,165
1974	81	1	2,507	53	1,504	12	172	586	11,013	5,192
1975	30	16	238	65	2,097	81	994	270	2,252	142
1976	7	11	242	101	1,746	3	286	387	3,880	2,626
1977	270	3	1,777	46	3,548	17	716	866	5,049	54
1978	10	55	67	275	1,314	92	530	573	11,512	1,584

* walleye, perch, and white bass only.

Table 28. Age composition of walleye taken in Ohio Division of Wildlife net run samples, 1978.

Location, Gear, Date	No. of Fish		Year Classes 1977	1976	1975	1974	1973	1972	1971	1970	1969	Percent Female	Mean Length (mm.)	Mean Age	Percent Legal
Sandusky Bay, Seine 6 April	150	%	--	3	35	33	8	12	5	4	<1				
		Avg. mm.	--	377	436	490	521	571	623	656	732				
		% female	--	0	7	31	42	61	43	100	100	30%	495	4.25	97%
Sandusky Bay, Seine 13 April	150	%	--	6	51	30	4	6	2	1	--				
		Avg. mm.	--	380	456	509	575	605	638	671	--				
		% female	--	0	74	80	100	89	100	100	--	74%	488	3.65	93%
Bono, Trap Net 19 April	153	%	2	9	60	27	<1	<1	--	<1	--				
		Avg. mm.	246	376	430	484	580	591	--	539	--				
		% female	--	0	26	46	0	100	--	0	--	29%	439	3.20	86
Sandusky Bay, Seine 20 April	150	%	--	8	51	31	5	3	1	1	--				
		Avg. mm.	--	383	446	493	534	607	590	664	--				
		% female	--	0	57	52	29	100	100	100	--	51%	467	3.49	93%
Port Clinton, Trap Net 24 April	150	%	--	6	67	22	1	3	1	--	--				
		Avg. mm.	--	378	425	483	490	556	541	--	--				
		% female	--	0	17	61	0	75	0	--	--	27%	440	3.29	89%
Bono, Trap Net 2 May	156	%	4	5	57	30	3	2	<1	<1	--				
		Avg. mm.	250	371	432	485	492	600	902	513	--				
		% female	--	38	65	60	75	100	100	0	--	60%	449	3.18	90%
Bono, Trap Net* 6 October	150	%	81	3	7	8	--	1	--	--	--				
		Avg. mm.	335	418	442	509	--	631	--	--	--				
		% female	52	40	20	92	--	100	--	--	--	53	361	1.44	10
Port Clinton, Trap Net* 2 November	178	%	93	<1	4	2	--	<1	<1	--	--				
		Avg. mm.	346	425	483	511	--	611	625	--	--				
		% female	46	0	71	0	--	100	100	--	--	47	357	1.20	8%

* Fall walleye samples provided by U.S. Fish & Wildlife Service, Sandusky Biological Station.

Table 29. Freshwater drum grid harvest by numbers.

		SHORE				BOAT				
		1975	1976	1977	TOTAL	1975	1976	1977	TOTAL	GRAND TOTAL
Winter	802	0	0	0	0					0
	903	0	0	0	0					0
	904	0	0	0	0					0
	905	0	0	0	0					0
	1004	0	0	0	0					0
	1005	0	0	0	0					0
Subtotal		0	0	0	0					0
Spring River	800	4,761	11,018	6,327	22,106					22,106
	1003	0	0	4,365	4,365					4,365
Subtotal		4,761	11,018	10,692	26,471					26,471
Summer District I	801	3,450	4,455	5,206	13,111	175	2,692	1,882	4,749	17,860
	802	203	*	*	203	55,130	845	7,624	63,599	63,802
	803	*	*	*	*	84	1,829	14,999	16,912	16,912
	804	*	*	*	*	1,823	20,479	8,855	31,157	31,157
	805	89	*	*	89	2,628	8,032	3,718	14,378	14,467
	806	*	*	*	*	0	0	0	0	0
	903	5,005	5,394	3,827	14,226	66,173	8,765	56,757	131,695	145,921
	904	13,438	27,327	30,928	71,693	55,849	29,082	19,233	104,164	175,857
	905	2,524	12,084	3,360	17,968	26,117	63,305	49,662	139,084	157,052
	906	*	*	*	*	855	539	4,674	6,068	6,068
	1006	2,921	4,650	1,348	8,919	8,269	4,205	6,008	18,482	27,401
		27,630	53,910	44,669	126,209	217,103	139,773	173,412	530,288	656,497
District II	812	*	*	*	*	0	0	0	0	0
	813	6,345	7,934	6,257	20,536	24,909	19,955	18,325	63,189	83,725
	907	*	*	*	*	0	0	0	0	0
	908	*	*	*	*	8,078	327	0	8,405	8,405
	909	2,527	5,202	8,566	16,295	229,203	27,560	39,998	296,761	313,056
	910	21,406	6,755	8,586	36,747	9,540	3,516	8,707	21,763	58,510
	911	41,206	41,515	11,611	94,332	20,410	11,083	1,698	33,191	127,523
	912	41,654	53,452	34,022	129,128	28,641	30,600	1,679	60,920	190,075
	1007	304	637	19	960	5,047	8,968	8,693	22,708	23,668
	1008	24,457	8,397	6,296	39,150	100,929	7,048	4,844	112,821	151,971
		137,899	123,892	75,357	337,148	426,757	109,057	83,944	619,758	956,906
District III	714	*	*	*	*	0	0	0	0	0
	715	*	*	*	*	0	0	0	0	0
	716	*	*	*	*	0	0	0	0	0
	717	12,144	8,886	14,607	35,637	56,295	13,693	8,667	78,655	114,292
	718	11,604	5,174	7,722	24,500	13,972	13,852	4,825	32,649	57,149
	814	19,407	13,362	12,725	45,495	4,243	1,435	1,924	7,602	53,096
		43,155	27,422	35,054	105,631	74,510	28,980	15,416	118,906	224,537
District IV	1004	*	*	*	*	0	22,980	0	22,980	22,980
	1005	22,339	19,057	11,456	52,852	21,028	35,524	5,004	61,556	114,408
		22,339	19,057	11,456	52,852	21,028	58,504	5,004	84,536	137,388
Subtotal		231,023	224,281	166,536	621,840	739,398	336,314	277,776	1,353,488	1,975,328
Charter	801					0	0	8	8	8
	802					0	0	0	0	0
	803					796	71	269	1,136	1,136
	804					1,963	398	565	2,926	2,926
	805					3,378	789	298	4,465	4,465
	806					625	43	66	734	734
	903					1,167	270	32	1,469	1,469
	904					1,647	467	392	2,506	2,506
	905					2,059	128	768	2,955	2,955
	906					0	0	0	0	0
	1006					465	40	0	505	505
	1005					398	343	241	982	982
	911					2,563	0	0	2,563	2,563
						15,061	2,549	2,638	20,248	20,248
Charter**	703-C					0	0	0	0	0
	704-C					0	0	0	0	0
	705-C					0	0	0	0	0
	706-C					0	0	0	0	0
	803-C					0	0	0	0	0
	804-C					0	252	0	252	252
	805-C					0	911	349	1,260	1,260
	806-C					0	160	17	177	177
						0	1,323	366	1,689	1,689
Subtotal						15,061	3,872	3,004	21,937	21,937
GRAND TOTAL		235,784	235,299	177,228	648,311	754,459	340,186	283,780	1,375,425	2,023,736

*No census location in grid.
**Canadian waters.

Table 30. Fall spottail shiner abundance (per hour trawling).

Age Group	Year	District I	District II	District III	Lakewide
Young-of-the-year	1973	1,068	140	1,000	784
	1974	296	32	192	192
	1975	244	12	44	120
	1976	126	102	139	122
	1977	562	61	1,439	702
	1978	131	1	108	80
Yearling and Adult	1973	228	116	88	152
	1974	116	80	304	204
	1975	564	196	48	308
	1976	58	25	35	41
	1977	128	62	279	158
	1978	61	174	264	160

Table 31. Fall emerald shiner abundance (per hour trawling).

Age Group	Year	District I	District II	District III	Lakewide
Young-of-the-year	1973	1,984	1,168	116	1,216
	1974	2,480	196	772	1,340
	1975	124	28	476	196
	1976	50	181	70	96
	1977	7,482	316	677	3,298
	1978	26	458	598	346
Yearling and Adult	1973	200	3,512	1,520	1,520
	1974	484	516	1,364	744
	1975	416	364	2,524	1,004
	1976	30	153	293	149
	1977	478	61	728	441
	1978	18	513	893	450

Table 32. Species common to abundant in exposed habitats.

Alewife
Gizzard shad
Coho salmon (locally)
Chinook salmon (locally)
Rainbow (steelhead) trout (locally)
Rainbow smelt
Emerald shiner
Spottail shiner
Longnose dace (locally)
White sucker
Shorthead redhorse
Longnose sucker (locally)
Channel catfish
Stonecat
Burbot
Troutperch
White bass
Logperch
Yellow perch
Walleye
Freshwater drum
Mottled sculpin

Table 33. Species common to abundant in unsheltered areas with structures present (also common in swiftly flowing streams)

Sand shiner
Mimic shiner
Brindled madtom
Rock bass
Green sunfish
Smallmouth bass
Johnny darter
Brook silverside

Table 34. Species once common in unsheltered areas with firm bottom

Silver lamprey
Lake sturgeon
Lake herring
Lake whitefish
Lake trout (eastern basin)
Mooneye
Silver chub
Eastern sand darter
Channel darter
Sauger

Table 35. Species seasonally present in sheltered waters

Silver lamprey
Lake sturgeon (rare)
Alewife
Lake herring (rare)
Lake whitefish (rare)
Coho salmon (locally)
Chinook salmon (locally)
Rainbow (steelhead) trout (locally)
Rainbow smelt
Longnose sucker
Shorthead redhorse
Channel catfish
White bass
Sauger
Walleye
Yellow perch
Freshwater drum

Table 36. Vegetation-dependent species tolerant of various bottom types but not tolerant of turbidity

Spotted gar
Longnose gar
Bowfin
Central mudminnow
Grass pickerel
Northern pike
Muskellunge
Chain pickerel
Goldenshiner
Pugnose shiner
Pugnose minnow
Blackchin shiner
Blacknose shiner
Yellow bullhead
Brown bullhead
Banded killifish
Brook stickleback
Pumpkinseed
Black crappie
Iowa darter

Table 37. Species not dependent on vegetation, but associated with vegetation in clear shallows with firm bottom.

White sucker

Stonecat

Rock bass

Smallmouth bass

Green sunfish

Eastern sand darter

Johnny darter

Logperch

Yellow perch

Table 38. Species common in all types of sheltered areas

White sucker
Carp
Goldfish
Gizzard shad
Bluntnose minnow
Emerald shiner
Spottail shiner
Quillback
Black bullhead
Channel catfish
White crappie
Freshwater drum

Table 39. Species which prefer clear waters with firm bottoms

Sand shiner
Mimic shiner
Silver redhorse
Golden redhorse
Black redhorse
Spotted sucker
Stonecat
Troutperch
White bass
Rock bass
Green sunfish
Bluegill
Smallmouth bass
Largemouth bass
Eastern sand darter
Greenside darter
Fantail darter
Johnny darter
Yellow perch
Logperch
Brook silverside

Table 40. Species present in both sheltered and unsheltered waters

White sucker
Gizzard shad
Emerald shiner
Spottail shiner
White bass
Yellow perch
Freshwater drum

Table 41. A list of species by critical area and habitat type
Species by spawning area

shallow protected, sand-mud, silt with vegetation	shallow protected, sand-mud, silt without vegetation	shallow exposed rock-rubble	shallow exposed gravel-sand	rubble-gravel, with current	mid-water
banded killifish	black bullhead	channel catfish	alewife	burbot	emerald shiner
bigmouth buffalo	bluegill sunfish	fantail darter	channel darter	freshwater drum	freshwater drum
black bullhead	bluntnose minnow	freshwater drum	e. sand darter	sauger,	silver chub
black crappie	bowfin	johnny darter	freshwater drum	smelt	
blacknose shiner	brindled madtom	rock bass	gizzard shad	walleye	
bluegill sunfish	brook silversides	sauger	logperch	white bass	
bluntnose minnow	brown bullhead	smallmouth bass	sand shiner	whitefish	
bowfin	carp	stonecat	spottail shiner	yellow perch	
brindled madton	fathead minnow	yellow perch	troutperch		
brook silversides	goldfish		white crappie		
brown bullhead	green sunfish		white perch		
carp	Iowa darter		yellow perch		
central mudminnow	largemouth bass				
fathead minnow	longnose gar				
golden shiner	mimic shiner				
goldfish	mottled sculpin				
grass pickerel	punpkinseed sunfish				
green sunfish	spotfin shiner				
gr.side darter	spotted gar				
Iowa darter	white crappie				
lake chubsucker	yellow bullhead				
largemouth bass					
muskellunge					
northern pike					
pugnose shiner					
pumpkinseed sunfish					
quillback					
spotfin shiner					
yellow bullhead					

Table 41-continued. Species by nursery area

shallow protected, sand, mud silt with vegetation	shallow protected, sand, mud silt without vegetation	shallow exposed rock and rubble	shallow exposed gravel and sand	medium mud	rubble-gravel, with current
banded killifish	black bullhead	channel catfish	alewife	bigmouth buffalo	stonecat
black bullhead	bluegill sunfish	fantail darter	channel catfish	carp	
black crappie	bluntnose minnow	lake sturgeon	channel darter	channel catfish	mid-water
blacknose shiner	brindled madtom	mottled sculpin	freshwater drum	freshwater drum	
bluegill sunfish	brook silversides	rock bass	gizzard shad	gizzard shad	emerald shiner
bluntnose minnow	brown bullhead	spotfin shiner	johnny darter	goldfish	freshwater drum
bowfin	carp	stonecat	logperch	lake sturgeon	smelt
brindled madtom	channel catfish	white bass	sand darter	stonecat	
brook silversides	fathead minnow	white sucker	sand shiner	troutperch	
brown bullhead	gizzard shad	yellow perch	sauger	white bass	deep gravel-sand
carp	goldfish		spotfin shiner	white crappie	
central mudminnow	green sunfish		spottail shiner		freshwater drum
channel catfish	largemouth bass		troutperch		smelt
channel darter	mimic shiner		walleye		troutperch
fathead minnow	pumpkinseed sunfish		white bass		
gizzard shad	smallmouth bass		white perch		deep mud
goldenshiner	spotfin shiner		white sucker		
goldfish	white crappie		yellow perch		freshwater drum
grass pickerel	yellow perch				troutperch
green sunfish					
gr. sided darter					
Iowa darter					
lake chubsucker					
largemouth bass					
longnose gar					
logperch					
muskellunge					
northern pike					
pugnose shiner					
pumpkinseed sunfish					
quillback					
spotfin shiner					
spotted gar					

Table41 -continued. Species by feeding area

shallow protected, sand, mud silt with vegetation	shall protected, sand, mud silt without vegetation	nearshore exposed rock-rubble	nearshore exposed gravel-sand	nearshore exposed mud bottom	offshore rock rubble
banded killifish	bigmouth buffalo	brown trout	bigmouth buffalo	bigmouth buffalo	channel catfish
bigmouth buffalo	black bullhead	carp	brown bullhead	brown bullhead	chinook salmon
black bullhead	bluegill	channel catfish	brown trout	carp	coho salmon
black crappie	bluntnose minnow	channel darter	carp	channel catfish	freshwater drum
blacknose shiner	brindled madtom	chinook salmon	channel catfish	freshwater drum	lake sturgeon
bluegill	brook silversides	coho salmon	channel darter	goldfish	sauger
bluntnose minnow	brown bullhead	fantail darter	chinook salmon	quillback	spottail shiner
bowfin	carp	freshwater drum	coho salmon	spottail shiner	stonecat
brindled madtom	fathead minnow	golden redhorse	fantail darter	troutperch	walleye
brook silversides	goldfish	mottled sculpin	freshwater drum	white sucker	white bass
brown bullhead	green sunfish	rock bass	golden redhorse	**offshore gravel-sand**	yellow perch
carp	largemouth bass	sauger	johnny darter	freshwater drum	**pelagic, central basin**
central mudminnow	mimic shiner	silver redhorse	lake sturgeon	johnny darter	chinook salmon
fathead minnow	pumpkinseed	smallmouth bass	logperch	lake sturgeon	coho salmon
golden shiner	quillback	spottail shiner	quillback	logperch	emerald shiner
goldfish	sauger	stonecat	sand darter	spottail shiner	silver chub
grass pickerel	white crappie	walleye	sand shiner	troutperch	smelt
green sunfish	yellow bullhead	white bass	sauger	walleye	**general central basin**
greensided darter		white sucker	silver redhorse	yellow perch	burbot
Iowa darter		yellow perch	spotfin shiner	**off shore mud bottom**	longnose sucker
lake chubsucker			spottail shiner	freshwater drum	spotted sucker
largemouth bass			stonecat	spottail shiner	whitefish
longnose gar			troutperch	troutperch	yellow perch
muskellunge			walleye	**pelagic, western basin**	
northern pike			white bass	alewife	
pugnose shiner			white crappie	emerald shiner	
pumpkinseed			white perch	gizzard shad	
quillback			white sucker	silver chub	
spotted gar			yellow perch		
tadpole madtom					
white crappie					
yellow bullhead					

Table 41-continued. Species by migration area

in and out of tributaries small tributaries	large tributaries	in and out from nearshore	in and out from offshore reefs	in and out of Maumee Bay and Sandusky Bay	along shore	offshore to and from deep water
alewife	bigmouth buffalo	alewife	burbot	channel catfish	coho salmon	alewife
bigmouth buffalo	brown trout	bigmouth buffalo	channel catfish	freshwater drum		freshwater drum
black bullhead	carp	burbot	freshwater drum	sauger		gizzard shad
brown bullhead	channel catfish	carp	sauger	walleye		lake sturgeon
carp	coho salmon	channel catfish	spottail shiner	white bass		smelt
channel catfish	freshwater drum	emerald shiner	stonecat	yellow perch		whitefish
coho salmon	gizzard shad	freshwater drum	walleye			
gizzard shad	golden redhorse	gizzard shad	white bass			
golden redhorse	goldfish	goldfish	yellow perch			
goldfish	grass pickerel	mottled sculpin				
grass pikerel	lake sturgeon	northern pike				
northern pike	northern pike	quillback				
northern redhorse	northern redhorse	smallmouth bass				
quillback	quillback	sauger				
rainbow trout	rainbow trout	spottail shiner				
silver lamprey	sauger	troutperch				
silver redhorse	silver lamprey	walleye				
smelt	silver redhorse	whitefish				
white bass	smallmouth bass	yellow perch				
white sucker	walleye					
yellow bullhead	white bass					
	white perch					
	white sucker					

Table 41-continued. Species by overwintering area

protected with vegetation	protected without vegetation	deep mud bottom adjacent to island reefs	50 ft. and deeper	nearshore rock and rubble	nearshore gravel and sand
banded killifish	black bullhead	carp	freshwater drum	alewife	alewife
black bullhead	bluegill sunfish	channel catfish	gizzard shad	channel darter	channel darter
black crappie	bluntnose minnow	gizzard shad	sand shiner	emerald shiner	emerald shiner
blacknose shiner	brindled madtom	goldfish	spottail shiner	fantail darter	johnny darter
bluegill sunfish	brook silversides	rock bass	troutperch	logperch	logperch
bluntnose minnow	brown bullhead	stonecat	white bass	mottled sculpin	smelt
bowfin	emerald shiner	walleye	white sucker	sand darter	yellow perch
brindled madtom	fathead minnow			smallmouth bass	
brook silversides	green sunfish			yellow perch	
brown bullhead	largemouth bass				
central mudminnow	mimic shiner				
fathead minnow	pumpkinseed sunfish				
grass pickerel	spotfin shiner	**reefs and shoals of the island area**	**heated effluent**	**nearshore mud bottom**	**deeper waters of the western basin**
gr. side darter	white crappie				
green sunfish	yellow bullhead				
Iowa darter		alewife	alewife	bigmouth buffalo	channel catfish
lake chubsucker		burbot	coho salmon	brown bullhead	freshwater drum
largemouth bass		coho salmon	gizzard shad	carp	golden redhorse
longnose gar		sauger		goldfish	northern redhorse
northern pike		whitefish		quillback	silver redhorse
pugnose shiner		yellow perch			spottail shiner
pumpkinseed sunfish					troutperch
spotfin shiner					walleye
spotted gar					white bass
tadpole madtom					white perch
white crappie					white sucker
yellow bullhead					

Table A2. Fish species and their habitats (E=Endangered)

Species (columns, in printed order): alewife, American eel, Atlantic salmon, banded killifish, bigmouth buffalo, black bullhead, black crappie, black redhorse, blackchin shiner, blacknose shiner, blue pike, bluegill, bluntnose minnow, bowfin, brindled madtom, brook silverside, brown bullhead, brown trout, burbot, carp, central mudminnow, channel catfish, channel darter, chinook salmon, e. sand darter, emerald shiner, fantail darter, fathead minnow, flathead catfish, freshwater drum, gizzard shad, golden redhorse, golden shiner, goldfish, grass pickerel, green sunfish, greenside darter, hogsucker, Iowa darter, Johnny darter, lake chubsucker, lake herring, lake sturgeon, lake trout, largemouth bass, logperch, longear sunfish, longnose gar, longnose sucker, mimic shiner, mooneye, mottled sculpin, muskellunge, northern pike, northern redhorse, orange spotted sunfish, paddlefish, pugnose minnow, pugnose shiner, pumpkinseed sunfish, quillback, rainbow trout, river darter, rock bass, sand shiner, sauger, sea lamprey, silver chub, silver lamprey, silver redhorse, smallmouth bass, smelt, spotfin shiner, spottail shiner, spotted gar, spotted sucker, stonecat madtom, stonecat, tadpole madtom, troutperch, walleye, white bass, white catfish, white crappie, white perch, white sucker, yellow bullhead, yellow perch

CRITICAL HABITAT TYPES		SPECIES
SPAWNING	strays	[illegible]
	shallow protected, sand-mud, silt with vegetation	[illegible]
	shallow protected, sand-mud, silt without vegetation	[illegible]
	shallow exposed rock-rubble	[illegible]
	shallow exposed gravel-sand	[illegible]
	rubble-gravel, with current	[illegible]
	mid-water	[illegible]
	tributary	[illegible]
NURSERY	strays	[illegible]
	shallow protected sand-mud, silt with vegetation	[illegible]
	shallow protected sand-mud, silt without vegetation	[illegible]
	shallow exposed rock and rubble	[illegible]
	shallow exposed gravel and sand	[illegible]
	medium mud	[illegible]
	rubble-gravel with current	[illegible]
	open water	[illegible]
	deep gravel-sand	[illegible]
	deep mud	[illegible]
	tributary	[illegible]
FEEDING	strays	[illegible]
	shallow protected sand-mud, silt with vegetation	[illegible]
	shallow protected sand-mud, silt without vegetation	[illegible]
	nearshore exposed rock-rubble	[illegible]
	nearshore exposed gravel-sand	[illegible]
	nearshore exposed mud bottom	[illegible]
	offshore rock-rubble	[illegible]
	offshore gravel-sand	[illegible]
	offshore mud bottom	[illegible]
	pelagic western basin	[illegible]
	pelagic central basin	[illegible]
	central central basin	[illegible]
	tributary	[illegible]
MIGRATION	in and out of small tributaries	[illegible]
	in and out of large tributaries	[illegible]
	in and out from nearshore	[illegible]
	in and out from offshore reefs	[illegible]
	in and out of Maumee Bay and Sandusky Bay	[illegible]
	along shore	[illegible]
	offshore to and from deep water	[illegible]
OVERWINTERING	strays	[illegible]
	protected with vegetation	[illegible]
	deep mud sediments (island reefs)	[illegible]
	30 ft. and deeper	[illegible]
	nearshore rock and rubble	[illegible]
	nearshore gravel and sand	[illegible]
	reefs and shoals of the island area	[illegible]
	heated effluent	[illegible]
	offshore mud bottom	[illegible]
	deeper waters of the central basin	[illegible]
	protected without vegetation	[illegible]

Table 43. Annual ice angler harvests, hours, and catch rates by species, 1975-1977.

Area Grid	Sandusky Bay (1004, 1005)	Catawba-Marblehead (904, 905)		Bass Islands (904, 805)		Reno Beach (802, 803)	Total
1975:							
Perch	11,928	10,456		638		0	23,0[illegible]
Angler Hours	6,292	4,680		901		0	11,873
FPAH	1.90	2.23		0.71		0	1.94
1976:							
Perch	17,568	18,136	(1,846)*	3,929	(20,908)*	0	39,633
Angler Hours	21,975	21,785	(3,152)*	4,672	(10,027)*	0	49,431
FPAH	0.80	0.83	(0.59)*	0.84	(2.09)*	0	0.82
1977:							
Perch	6,964	56,296	(2,728)*	21,164	(34,116)*	77,969	162,3[illegible]
Angler Hours	8,946	33,589	(4,496)*	10,674	(12,651)*	19,510	72,7[illegible]9
FPAH	0.78	0.60	(0.61)*	1.98	(2.70)*	4.00	2.2[illegible]

*Harvest reported by ice guides.

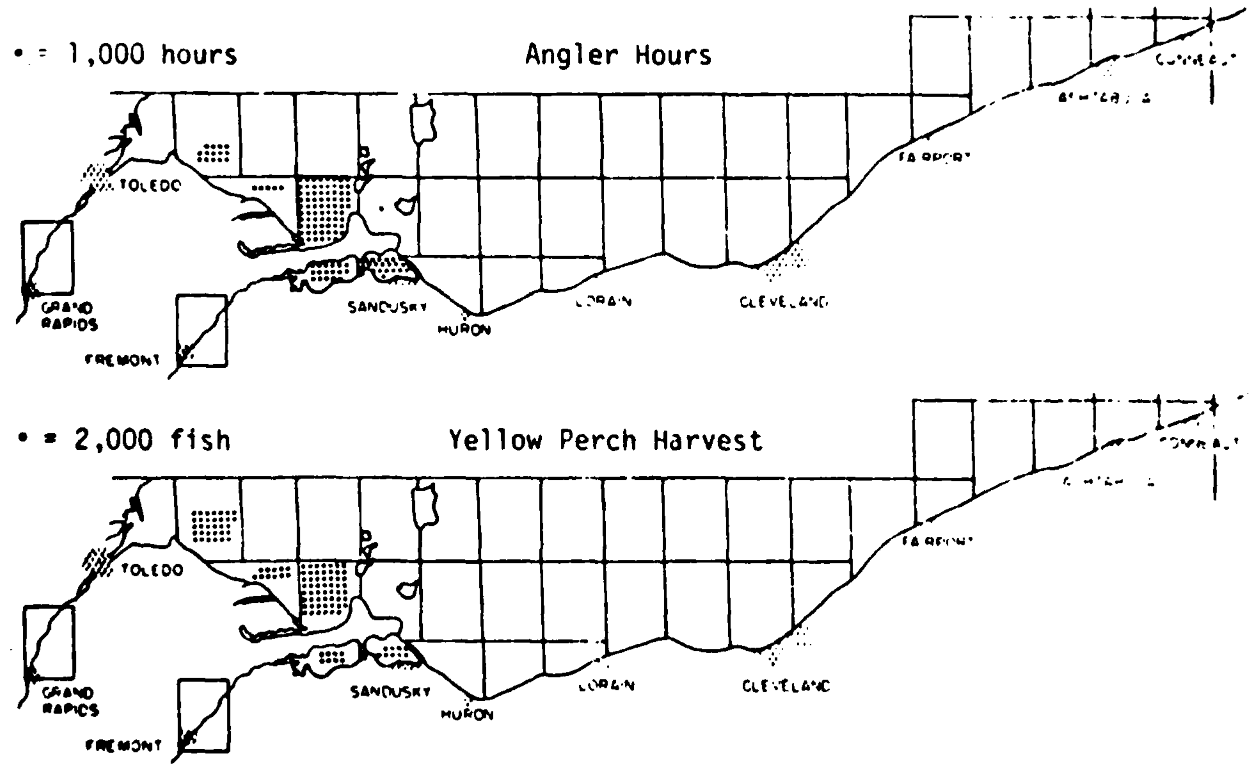


Figure 20. Angler hours and yellow perch harvest - winter ice fishery 1975-1977.

Table 44. Annual shore angler harvests, hours, and catch rates by species, 1975-1977.

Species/ Survey Year	Western Basin			Central Basin			Lakewide Total		
	Numbers Harvested	Angler Hours	FPAH	Numbers Harvested	Angler Hours	FPAH	Numbers Harvested	Angler Hours	FPAH
Yellow Perch:									
1975	373,850	289,975	1.06	322,350	328,950	0.72	696,200	618,925	0.90
1976	200,250	187,500	0.86	164,175	239,075	0.51	364,425	426,575	0.68
1977	280,425	217,450	1.07	275,850	268,675	0.89	556,275	486,125	0.99
White Bass:									
1975	38,225	5,900	0.70	250,975	63,775	2.00	289,200	69,675	1.85
1976	18,000	6,700	1.53	155,425	86,850	1.65	173,425	93,550	1.64
1977	20,175	8,075	1.18	338,325	103,300	2.98	358,500	111,375	2.81
Freshwater Drum:									
1975	49,975	1,025	0.25	181,050	11,500	0.70	231,025	12,525	0.66
1976	72,975	3,900	1.66	151,325	15,025	0.63	224,300	18,925	0.97
1977	56,125	1,225	0.73	110,400	13,275	1.18	166,525	14,500	1.12
Channel Catfish:									
1975	19,325	61,400	0.23	10,650	35,675	0.17	29,975	97,075	0.22
1976	22,175	55,525	0.24	3,075	12,975	0.08	25,250	68,500	0.22
1977	19,850	34,125	0.37	2,500	5,850	0.05	22,350	39,975	0.34
Smallmouth Bass:									
1975	1,900	3,125	0.15	1,650	4,775	0.20	3,550	7,900	0.17
1976	625	1,625	0.10	475	2,375	0.08	1,125	4,000	0.09
1977	100	1,175	0.01	1,500	6,825	0.23	1,600	8,000	0.19
Walleye:									
1975	300	300	0.05	925	3,050	0.09	1,225	3,350	0.08
1976	100	50	0.00	300	550	0.00	400	600	0.00
1977	350	450	0.00	275	950	0.05	625	1,400	0.05
Other Species:									
1975	108,400	58,675	0.74	55,500	17,975	0.82	163,900	76,650	0.76
1976	40,250	17,350	0.50	47,975	23,300	0.69	88,225	40,650	0.61
1977	19,700	8,600	0.75	35,650	10,650	0.56	55,350	19,250	0.68
Anything That Bites:									
1975	---	160,650	0.69	---	444,500	0.59	---	605,150	0.63
1976	---	191,150	0.57	---	329,725	0.52	---	520,875	0.54
1977	---	105,100	0.76	---	222,475	0.72	---	327,575	0.74

Table 45. Annual boat angler harvests, hours, and catch rates by species, 1975-1977.

Species/ Survey Year	Western Basin Numbers Harvested	Western Basin Angler Hours	FPAH	Central Basin Numbers Harvested	Central Basin Angler Hours	FPAH	Lakewide Total Numbers Harvested	Lakewide Total Angler Hours	FPAH
Yellow Perch:									
1975	5,197,575	2,143,950	2.63	2,164,375	1,157,900	1.81	7,361,950	3,301,850	2.31
1976	5,071,000	1,711,400	3.53	914,100	648,600	[illegible]	5,985,100	2,360,000	2.99
1977	9,120,350	2,348,125	4.45	1,360,200	829,200	1.64	10,480,550	3,177,325	[illegible]
Walleye:									
1975	70,150	580,975	0.12	10,150	79,250	0.12	80,300	660,225	0.12
1976	588,125	1,652,525	0.32	35,375	201,975	0.16	623,500	1,854,500	0.31
1977	2,057,600	3,325,025	0.61	36,775	185,100	0.20	2,094,375	3,510,125	0.59
White Bass:									
1975	175,475	94,500	1.08	1,331,000	507,800	1.99	1,506,475	602,300	1.99
1976	200,625	117,600	1.25	447,750	184,075	[illegible]	648,375	301,675	1.79
1977	85,800	80,650	0.52	784,325	219,825	3.25	870,125	300,475	2.67
Freshwater Drum:									
1975	238,125	2,475	0.59	501,275	5,475	1.52	739,400	7,950	1.16
1976	198,275	3,450	1.34	138,050	3,750	0.90	336,325	7,200	1.09
1977	178,425	6,800	2.00	99,350	2,500	0.56	277,775	9,300	1.64
Channel Catfish:									
1975	131,025	145,850	0.60	57,350	59,750	0.28	188,375	205,600	0.59
1976	173,200	116,000	0.63	32,550	11,500	0.65	205,750	127,500	0.63
1977	115,775	86,175	0.84	17,525	11,900	0.40	133,300	98,075	0.75
Smallmouth Bass:									
1975	12,050	77,900	0.12	18,350	49,150	0.16	30,400	129,050	0.14
1976	27,100	102,875	0.13	3,300	8,525	0.13	30,400	111,400	0.11
1977	15,175	44,500	0.11	5,750	17,800	0.05	20,925	62,300	0.09
Other Species:									
1975	50,625	19,300	0.50	92,975	31,200	0.13	143,600	50,500	0.22
1976	40,225	6,750	0.89	40,300	39,350	0.12	80,525	46,100	0.21
1977	11,975	7,875	0.98	36,175	19,925	0.03	48,150	27,800	0.13
Anything That Bites:									
1975	---	125,800	1.44	---	388,325	1.32	---	514,125	1.34
1976	---	276,525	0.93	---	174,650	0.79	---	451,175	0.87
1977	---	151,000	0.57	---	145,950	0.92	---	296,950	0.75

Table 46. Grid angler hours by type anglers.

		SHORE				BOAT				
		1975	1976	1977	TOTAL	1975	1976	1977	TOTAL	GRAND TOTAL
Winter	802	0	0	14,468	14,468					14,468
	903	0	0	5,042	5,042					5,042
	904	5,339	25,987	43,578	74,899					74,899
	905	242	474	685	1,401					1,401
	1004	4,096	10,982	2,562	17,640					17,640
	1005	2,200	10,993	6,384	19,577					19,577
Subtotal		11,877	48,431	72,719	133,027					133,027
Spring River	800	214,107	186,832	125,675	526,614					526,614
	1003	168,769	116,141	215,350	500,260					500,260
Subtotal		382,876	302,973	341,025	1,026,874					1,026,874
Summer District I	801	47,938	51,238	54,621	153,847	13,045	72,439	72,540	158,024	311,871
	802	2,994	*	*	2,994	344,108	31,374	446,076	821,558	824,552
	803	*	*	*	*	1,222	77,191	439,124	517,537	517,537
	804	*	*	*	*	69,419	310,964	347,723	728,106	728,106
	805	5,639	*	*	5,639	129,126	350,025	209,898	689,049	694,688
	806	*	*	*	*	8,601	30,825	28,462	67,888	67,888
	903	85,484	53,979	63,318	202,781	749,509	1,080,397	1,926,282	3,756,188	3,958,969
	904	121,966	83,678	73,403	278,847	825,123	515,565	578,430	1,919,118	2,197,965
	905	34,591	38,701	25,633	98,925	879,401	1,047,205	1,600,114	3,526,720	3,625,645
	906	*	*	*	*	8,951	46,342	58,759	114,052	114,052
	1006	58,467	69,127	45,009	172,603	103,47[illegible]	200,201	227,854	531,529	704,13[illegible]
		356,929	296,723	261,984	915,636	3,131,979	3,762,528	5,935,262	12,829,769	13,745,4[illegible]
District II	812	*	*	*	*	2,154	0	0	2,154	2,154
	813	37,998	30,100	45,181	113,279	95,327	76,861	118,792	290,980	404,259
	907	*	*	*	*	4,168	2,424	0	6,592	6,592
	908	*	*	*	*	15,934	4,619	1,390	21,943	21,943
	909	2,315	28,710	43,973	74,998	764,747	218,369	277,635	1,260,751	1,335,749
	910	69,335	40,713	52,099	162,147	48,788	35,908	62,326	147,022	309,169
	911	187,613	159,253	71,928	418,794	147,332	106,565	96,235	350,132	768,926
	912	209,834	209,084	140,124	559,042	176,773	114,716	160,383	451,872	1,010,914
	1007	6,292	1,317	933	8,542	110,999	235,726	196,689	543,414	551,956
	1008	214,151	120,315	130,666	456,132	448,009	182,523	162,398	792,930	1,258,062
		727,538	589,492	484,904	1,801,934	1,814,231	977,711	1,075,848	3,867,790	5,669,724
District III	714	*	*	*	*	0	2,372	1,338	3,710	3,710
	715	*	*	*	*	3,423	10,086	1,177	14,686	14,686
	716	*	*	*	*	563	0	328	891	891
	717	29,572	18,235	34,077	81,886	218,625	83,762	154,315	456,702	538,588
	718	42,433	27,890	30,838	101,161	190,639	171,348	139,455	501,442	602,603
	814	92,030	74,002	82,150	248,182	51,342	29,216	59,714	140,272	388,454
		164,035	120,127	147,067	431,229	464,592	296,784	356,327	1,117,703	1,548,932
District IV	1004	*	*	*	*	2,650	40,496	2,670	45,816	45,816
	1005	200,869	156,216	114,252	471,337	56,155	184,069	112,245	352,469	823,806
		200,869	156,216	114,252	471,337	58,805	224,565	114,915	398,285	869,622
Subtotal		1,449,371	1,162,558	1,008,207	3,620,136	5,469,607	5,261,588	7,482,352	18,213,547	21,833,693
Charter	801					0	0	51	51	51
	802					0	0	199	199	199
	803					931	1,529	17,199	19,659	19,659
	804					3,667	5,110	25,067	33,844	33,844
	805					12,274	3,646	8,542	24,462	24,462
	806					1,896	1,414	1,833	5,143	5,143
	903					1,887	1,426	7,109	10,422	10,422
	904					10,904	3,902	35,089	49,895	49,895
	905					6,134	11,584	11,564	29,282	29,282
	906					76	304	491	871	871
	1006					12,621	3,170	2,373	18,164	18,164
	1005					3,101	3,805	1,859	8,765	8,765
	911					20,496	0	0	20,496	20,496
						73,987	35,890	111,376	221,253	221,253
Charter**	703-C					0	60	0	60	60
	704-C					0	0	456	456	456
	705-C					0	0	30	30	30
	706-C					0	194	48	242	242
	803-C					0	68	372	440	440
	804-C					0	2,394	1,884	4,278	4,278
	805-C					0	12,323	8,706	21,029	21,029
	806-C					0	2,222	1,535	3,757	3,757
						0	17,261	13,031	30,292	30,292
Subtotal						73,987	53,151	124,407	251,545	251,545
GRAND TOTAL		1,844,124	1,513,962	1,421,951	4,780,037	5,543,594	5,314,739	7,606,759	18,465,092	22,245,129

*No census location in grid
**Canadian waters.

Table 47. Ohio's sport and commercial harvest.

Species	Western Basin Harvest*		Central Basin Harvest		Total Harvest	
	Sport	Commercial	Sport	Commercial	Sport	Commercial
Perch						
1975	503,301	54,973	310,781	620,194	814,082	675,167
1976	443,387	41,619	117,976	610,875	561,363	652,494
1977	860,497	67,841	173,012	987,336	1,033,509	1,055,177
	1,807,185	164,433	601,769	2,218,465	2,408,954	2,382,838
White Bass						
1975	112,896	737,549	368,893	22,286	481,789	759,835
1976	155,030	651,533	99,994	28,613	255,024	680,146
1977	131,375	490,799	129,101	10,303	260,476	501,102
	399,301	1,879,881	597,988	62,202	997,289	1,941,083
Freshwater Drum						
1975	156,584	281,741	435,398	58,501	591,982	340,242
1976	166,037	272,767	184,545	159,176	350,582	431,943
1977	143,494	160,185	108,995	204,827	252,489	365,012
	466,115	714,693	728,938	422,504	1,195,053	1,137,1[illegible]7
Channel Catfish						
1975	55,773	115,220	29,712	2,151	85,485	117,37[illegible]
1976	81,784	100,073	16,489	1,152	98,273	101,225
1977	64,625	115,337	9,415	589	74,040	115,926
	202,187	330,630	55,616	3,892	257,798	334,522
Walleye						
1975	86,944	-0-	4,529	-0-	91,473	-0-
1976	479,184	-0-	23,297	-0-	502,481	-0-
1977	2,069,515	-0-	29,158	-0-	2,098,673	-0-
	2,635,643	-0-	56,984	-0-	2,692,627	-0-
All Species						
1975	926,922	2,563,094	1,159,974	735,370	2,086,896	3,292,464
1976	1,340,684	2,672,185	444,329	858,034	1,785,013	3,530,219
1977	3,278,182	2,644,579	453,535	1,225,961	3,731,717	3,870,540
	5,545,788	7,879,858	2,057,838	2,819,365	7,603,626	10,699,[illegible]

*Western basin harvest includes ice and river fisheries.

Table 48. Commercial landings and trends.

SPECIES	1976	PERCENT OF TOTAL	1977	PERCENT OF TOTAL	1978	PERCENT OF TOTAL	PERCENT CHANGE 1977-1978
BUFFALO	30	< 1%	35	< 1%	36	< 1%	+ 4%
BULLHEAD	43	1%	62	1%	73	< 1%	+ 18%
CARP	2,635	34%	2,753	32%	1,546	17%	- 44%
CATFISH	223	3%	256	3%	205	2%	- 20%
FRESHWATER DRUM	952	12%	805	9%	1,189	13%	+ 48%
GIZZARD SHAD	604	8%	504	6%	1,557	17%	+ 209%
GOLDFISH	134	2%	551	7%	757	8%	+ 38%
QUILLBACK	127	2%	103	1%	103	1%	---
SMELT	35	< 1%	1	< 1%	14	< 1%	+ 889%
SUCKERS	63	1%	33	< 1%	34	< 1%	+ 3%
WHITE BASS	1,499	19%	1,105	13%	1,687	18%	+ 53%
YELLOW PERCH	1,438	18%	2,326	27%	2,111	23%	- 9%
TOTAL	7,783		8,533		9,313		+ 9%

*Thousands of Pounds

Table 49. Landings by months. 1978.

SPECIES	MARCH	APRIL	MAY	JUNE	JULY	AUGUST	SEPTEMBER	OCTOBER	NOVEMBER	DECEMBER	TOTAL
BUFFALO	--	15,111	12,480	692	44	78	649	5,434	1,873	18	[illegible]
BULLHEAD	--	45,019	6,917	1,085	145	577	3,072	8,302	4,218	2,138	[illegible]
CARP	1,164	836,593	164,536	221,854	97,108	7,755	13,296	44,901	91,836	66,882	1,545,92[illegible]
CATFISH	3	61,012	91,108	19,167	4,933	5,801	5,931	9,243	7,341	305	[illegible]
FRESHWATER DRUM	--	215,160	301,884	396,060	30,812	44,438	75,680	82,677	40,286	2,316	1,149,3[illegible]
GIZZARD SHAD	--	686,327	263,860	511,429	14,025	100	1,125	49,758	26,130	4,350	1,157,104
GOLDFISH	--	306,965	127,100	180,860	16,160	11,295	23,520	51,333	23,617	16,312	757,16[illegible]
QUILLBACK	--	37,008	33,192	8,762	3,171	504	4,562	10,034	5,236	175	102,6[illegible]
SMELT	--	--	--	--	--	--	--	80	10,843	2,767	13,69[illegible]
SUCKERS	--	17,863	3,730	1,501	542	373	1,373	4,942	3,296	166	33,78[illegible]
WHITE BASS	--	87,049	485,793	110,972	14,383	10,149	87,892	533,161	350,957	6,949	1,68[illegible]
YELLOW PERCH	5,439	499,472	339,581	156,271	28,475	187,768	311,105	314,651	231,738	36,319	[illegible]
TOTAL	6,606	2,807,579	1,832,181	1,608,653	209,798	268,838	528,205	1,114,516	797,371	13[illegible]	9,31[illegible]

*Pounds

Table 50. Landings by species, districts, and gear. 1978.

SPECIES	DISTRICT	GILL NETS Pounds	GILL NETS %	TRAP NETS Pounds	TRAP NETS %	SEINES Pounds	SEINES %	TROT LINES Pounds	TROT LINES %	TOTAL Pounds	TOTAL %
BUFFALO	1			24,440		3,042				27,482	
	2			41						41	
	3										
	4					3,693				3,693	
	5					5,163				5,163	
	TOTAL			24,481	67.3	11,898	32.7			36,379	.4
BULLHEAD	1			15,567		6,119				21,686	
	2										
	3										
	4					51,552		235		51,787	
	5										
	TOTAL			15,567	21.2	57,671	78.5	235	.3	73,473	.8
CARP	1			74,974		651,516				726,490	
	2	873		2,396						3,269	
	3										
	4					660,886		30		660,916	
	5					155,250				155,250	
	TOTAL	873	.1	77,370	5.0	1,467,652	94.9	30		1,545,925	16.6
CATFISH	1			58,003		55,897		5,300		119,200	
	2	985		4,765						5,750	
	3	57								57	
	4					70,142		9,695		79,837	
	5										
	TOTAL	1,042	.6	62,768	30.6	126,039	61.5	14,995	7.3	204,844	2.2
FRESHWATER DRUM	1			174,375		45,091		130		219,596	
	2	107,125		2,296						109,421	
	3	187,642								187,642	
	4					670,351				670,351	
	5					2,305				2,305	
	TOTAL	294,767	24.8	176,671	14.9	717,747	60.3	130		1,189,315	12.8
GIZZARD SHAD	1					137,429				137,429	
	2	29,598								29,598	
	3										
	4					1,348,077				1,348,077	
	5					42,000				42,000	
	TOTAL	29,598	1.9			1,527,506	98.1			1,557,104	16.7

Table 50. (cont.) Landings by species, districts, and gear. 1978.

SPECIES	DISTRICT	GILL NETS Pounds	%	TRAP NETS Pounds	%	SEINES Pounds	%	TROT LINES Pounds	%	TOTAL Pounds	%
GOLDFISH	1			120		113,380				113,500	
	2										
	3										
	4					643,662				643,662	
	5										
	TOTAL			120	.1	757,042	99.9			757,162	8.1
QUILLBACK	1			63,381		20,455				83,836	
	2			994						994	
	3										
	4					13,544				13,544	
	5					4,270				4,270	
	TOTAL			64,375	62.7	38,269	37.3			102,644	1.1
SMELT	1										
	2	8,785								8,785	
	3	4,905								4,905	
	4										
	5										
	TOTAL	13,690	100.0							13,690	.1
SUCKERS	1			25,635		1,944				27,579	
	2			3,050						3,050	
	3										
	4					2,824				2,824	
	5					335				335	
	TOTAL			28,685	84.9	5,103	15.1			33,788	.4
WHITE BASS	1			1,395,202		27,283				1,422,485	
	2	88,638		29,354						117,992	
	3	5,188								5,188	
	4					141,680				141,680	
	5										
	TOTAL	93,826	5.6	1,424,556	84.4	168,963	10.0			1,687,345	18.1
YELLOW PERCH	1			151,418		9,833				161,251	
	2	1,216,314		10,718						1,227,032	
	3	711,490								711,490	
	4					11,086				11,086	
	5										
	TOTAL	1,927,804	91.3	162,136	7.7	20,919	1.0			2,110,859	22.7
TOTAL	1			1,983,115		1,071,989		5,430		3,060,534	32.9
	2	1,452,318		53,614						1,505,932	16.2
	3	909,282								909,282	9.8
	4					3,617,497		9,960		3,627,457	38.9
	5					209,323				209,323	2.2
	TOTAL	2,361,600	25.3	2,036,729	21.9	4,898,809	52.6	15,390	.2	9,312,528	

Table 51. Amphibians and reptiles of the southeastern Lake Erie area and their habitats

Name	Habitat Preference
Mudpuppy* _Necturus m. maculosus_	Lakes, ponds, and streams
Jefferson salamander* _Ambystoma jeffersonianum_	Mixed or deciduous woods with swamps, pools, or slow streams
Blue-spotted salamander _Ambystoma laterale_	Similar to Jefferson salamander
Spotted salamander* _Ambystoma maculatum_	Mixed or deciduous forests near ponds or slow streams
Small-mouthed salamander* _Ambystoma texanum_	Under logs and debris near ponds, swamps, and river bottoms
Marbled salamander _Ambystoma opacum_	Habitats varied; range from moist sandy or gravelly areas to dry hillsides
Eastern tiger salamander* _Ambystoma t. tigrinum_	Comparatively dry areas; terrestrial
Red-spotted newt _Diemictylus v. viridesens_	Red eft stage found in moist plant growth; adult stage found in ponds, small lakes, marshes, or other water bodies
Red-backed salamander* _Plethodon c. cinereus_	Woodlands; terrestrial
American toad* _Bufo a. americanus_	Habitats varied
Fowler's toad _Bufo woodhousei fowleri_	Sandy areas along lake shores or river valleys
Northern spring peeper _Hyla c. crucifer_	Brushy, second-growth woodlots with small, fairly permanent ponds or swamps
Eastern gray tree frog _Hyla v. versicolor_	Brush or small trees
Western chorus frog _Pseudacris t. triseriata_	Habitats varied
Blanchard's cricket frog _Acris crepitans blanchardi_	Permanent bodies of shallow water with emergent or shoreline vegetation; sand or gravel bars of intermittent streams
Bullfrog* _Rana catesbeiana_	Lakes, ponds, and bogs
Green frog _Rana clamitans melanota_	Springs, creeks, ditches, ponds, and lakes
Northern leopard frog* _Rana p. pipiens_	Open country

Table 51. Amphibians and reptiles of the southeastern Lake Erie area and their habitats (continued)

Name	Habitat Preference
Wood frog Rana sylvatica	Moist woods
Five-lined skink Eumeces fasciatus	Damp woods with logs and forest litter
Snapping turtle* Cholydra serpentina	Permanent water
Stinkpot Sternothaerus odoratus	Quiet waters of shallow, clear ponds, and rivers
Spotted turtle Clemmys guttata	Marshy meadows, bogs, swamps, small ponds, and other shallow water bodies
Eastern box turtle Terrapene c. carolina	Habitats varied
Map turtle* Graptemys geographica	Larger bodies of water; lakes, streams, and shores of Lake Erie islands
Midland painted turtle* Graptemys picta marginata	Quite shallow water close to heavy growths of aquatic vegetation
Blandings turtle* Emydoidea blandingi	Marshes, bogs, and other wetlands
Blue racer* Colvber constrictor foxi	Prairies, open woodlands, lakes, and tamarack-spagnum bogs
Northern water snake* Natrix a. sipedon	Habitats varied
Lake Erie water snake* Natrix a. insularum	Limited distribution; Put-in-Bay and neighboring Lake Erie islands
Queen snake Natrix septemvittata	Under rocks or debris at stream, pond, and lake edges
Kirtland's water snake* Natrix kirtlandi	Wet meadows
Eastern milk snake Lampropeltis doliata triangulum	Fields, woodlands, rocky hillsides, and river bottoms
Northern brown snake* Storeria o. dekayi	Bogs, swamps, freshwater marshes, and residential areas
Midland brown snake Storeria d. wrightorum	Similar to northern brown snake
Butler's garter snake Thamnophis butleri	Open prairie

Table 51. Amphibians and reptiles of the southeastern Lake Erie area and their habitats (continued)

Name	Habitat Preference
Eastern garter snake *Thamnophis s. sirtalis*	Habitats varied
Black rat snake* *Elaphe o. obsoleta*	Rocky, timbered hillsides to flat farmlands
Eastern fox snake* *Elaphe vulpina gloydi*	Limited distribution; Lake Erie marshes and immediate environs
Northern ringneck snake* *Diadophis punctatus edwardsi*	Wood hillsides
Eastern hognose snake* *Heterodon platyrhinos*	Sandy areas and open woods

* Noted as occurring on the Lake Erie islands; from Table 42 of Cooper and Herdendorf (1977)

Table 52. Bird List of Ottawa National Wildlife Refuge Complex, Ohio[/1]

Symbols used are as follows:

RESIDENT STATUS

S - spring March-May
s - summer June-August
F - fall September-November
W - winter December-February
* - nests locally

ABUNDANCE

a - abundant a common species which is very numerous
c - common certain to be seen insuitable habitat
u - uncommon present, but not certain to be seen
o - occasional seen only a few times during a season
r - rare seen at intervals of 2 to 5 years
x - accidental has been seen only once or twice

	S	s	F	W
Common loon	r		r	
Horned grebe	u		u	r
Eared grebe	r		r	
Pied-billed grebe*	c	c	c	r
White pelican	r	r	r	
Double-crested cormorant	o	o	o	
Great blue heron*	c	c	c	c
Green heron*	c	c	c	
Little blue heron	r	o	o	
Cattle egret	u	u	u	
Great egret*	c	c	c	
Snowy egret	x	r	r	
Louisiana heron	r		r	
Black-crowned night heron*	c	c	c	o
Yellow-crowned night heron	r	r		
Least bittern*	o	o	o	
American bittern*	u	u	u	r
Glossy ibis	o	o	r	
Mute swan	r	r	r	
Whistling swan	a	x	c	o
Canada goose*	a	a	a	a
Barnacle goose	x	x	x	x
White-fronted goose	r		x	x
Snow goose	o		c	u
Mallard*	a	a	a	a
Black duck*	c	c	c	c
Gadwall*	c	u	c	r
Pintail*	a	u	c	u
Green-winged teal*	c	u	c	o
Blue-winged teal*	c	c	a	x

	S	s	F	W
European wigeon	r		r	
American wigeon*	a	u	a	o
Northern shoveler*	c	u	c	r
Wood duck*	c	c	c	r
Redhead*	c	u	c	o
Ring-necked duck	c		u	r
Canvasback	a		c	c
Greater scaup	r		r	r
Lesser scaup*	a	u	c	u
Common goldeneye	c		c	c
Bufflehead	c		c	u
Oldsquaw	r		r	r
White-winged scoter	o		o	o
Surf scoter	o		o	o
Common scoter			o	r
Ruddy duck*	a	o	c	u
Hooded merganser*	c	u	c	u
Common merganser	a		a	u
Red-breasted merganser	c	x	u	r
Turkey vulture	c	u	u	
Goshawk	r		r	r
Sharp-shinned hawk	c		u	r
Cooper's hawk*	o	r	o	o
Red-tailed hawk*	c	c	c	c
Red-shouldered hawk*	u		u	o
Broad-winged hawk	c		c	
Rough-legged hawk	u		u	c
Golden eagle	r		r	r
Bald eagle*	u	u	u	u
Marsh hawk	u		u	u

Table 52. Bird List of Ottawa National Wildlife Refuge Complex, Ohio/1 (continued)

	S	s	F	W		S	s	F	W
Osprey	u	r	u		Herring gull*	a	c	a	a
Peregrine falcon	r		o	r	Ring-billed gull*	a	c	a	a
Merlin	r		r	r	Franklin's gull	o	o	o	x
American kestrel*	c	c	c	c	Bonaparte's gull	c	o	a	c
Ring-necked pheasant*	u	u	u	u	Forster's tern	u	c	c	
Sandhill crane	r		x		Common tern*	c	c	c	
King rail*	o	o	o	r	Caspian tern	c	c	c	
Virginia rail*	u	u	u	r	Black tern*	c	u	c	
Sora rail*	c	u	c	r	Rock dove*	c	c	c	c
Common gallinule*	c	c	c		Mourning dove*	c	c	c	c
American coot*	a	c	a	u	Yellow-billed cuckoo*	u	u	c	
Semipalmated plover	c	x	c		Black-billed cuckoo*	u	u	c	
Piping plover*	r	r	r		Barn owl	r	r	r	r
Killdeer*	a	c	a	r	Screech owl*	c	c	c	c
American golden plover	c		c		Great horned owl*	c	c	c	c
Black-bellied plover	c	o	u		Snowy owl	r		r	r
Ruddy turnstone	c	o	u		Barred owl*	r	r	r	r
American woodcock*	u	u	u		Long-eared owl*	r	r	r	r
Common snipe*	c	o	c	x	Short-eared owl	o		o	o
Whimbrel	r	r	r		Saw-whet owl*	o		o	r
Upland sandpiper*	o	o	u		Whip-poor will	u			
Spotted sandpiper*	c	c	c		Common nighthawk*	c	c	c	
Solitary sandpiper	c	c	c		Chimney swift*	c	u	c	
Willet	r	x	r		Ruby-throated hummingbird*	u	u	u	
Greater yellowlegs	c	c	c		Belted kingfisher*	c	c	c	r
Lesser yellowlegs	c	c	c		Common flicker*	c	c	c	o
Red knot	u	o	o		Red-bellied woodpecker*	u	u	u	u
Pectoral sandpiper	c	c	c		Red-headed woodpecker	u	u	u	u
White-rumped sandpiper	r	r	r		Yellow-bellied sapsucker	c		c	r
Baird's sandpiper	r	r	r		Hairy woodpecker	u	u	u	u
Least sandpiper	c	c	c		Downy woodpecker*	c	c	c	c
Dunlin	a	o	a	r	Eastern kingbird*	c	c	c	
Short-billed dowitcher	c	c	c		Great crested flycatcher*	c	c	c	
Long-billed dowitcher	u	u	u		Eastern phoebe*	c	u	u	
Stilt sandpiper		u	u		Yellow-bellied flycatcher	u		u	
Semipalmated sandpiper	a	c	a		Acadian flycatcher*	r	r	r	
Western sandpiper	r	o	o		Willow flycatcher*	c	c	c	
Buff-breasted sandpiper		o	o		Alder flycatcher	r			
Marbled godwit	o	o	o		Least flycatcher*	c	c	c	
Hudsonian godwit	r	o	o		Eastern wood pewee	c	c	c	
Ruff	r	r	r		Olive-sided flycatcher	u	u	u	
Sanderling	o	o	c	x	Horned lark*	c	c	c	c
Red phalarope			r	x	Tree swallow*	c	c	a	
Wilson's phalarope	o	o	o		Bank swallow*	c	a	c	
Northern phalarope	o	o	o	x	Rough-winged swallow*	c	u	u	
American avocet	r	r	r		Barn swallow*	c	c	c	
Parasitic jaeger		x	r		Cliff swallow*	u	u	u	
Glaucous gull	r		r	r	Purple martin*	c	c	c	
Iceland gull			r	r	Blue jay*	a	c	c	c
Great black-backed gull	c	u	c	c	Common crow*	c	o	c	o

Table 52. Bird List of Ottawa National Wildlife Refuge Complex, Ohio/1 (continued)

	S	s	F	W		S	s	F	W
Black-capped chickadee	o		o	o	Blackburnian warbler	c		c	
Tufted titmouse*	u	u	u	u	Chestnut-sided warbler	c		c	
White-breasted nuthatch	u	u	u	u	Bay-breasted warbler	c		c	
Red-breasted nuthatch	o		o	o	Blackpoll warbler	c		c	
Brown creeper	c		u	u	Pine warbler	o		o	
House wren	c	c	c		Kirtland's warbler	r			
Winter wren	u		u	u	Prairie warbler	o		o	
Carolina wren*	r	r	r	r	Palm warbler	c		c	
Long-billed marsh wren*	u	u	u	r	Ovenbird*	c	o	c	
Short-billed marsh wren*	r	r	r		Northern waterthrush	c		c	
Mockingbird*	o	o	o	o	Connecticut warbler	r		r	
Gray catbird*	c	c	c	r	Mourning warbler	u		u	
Brown thrasher*	c	c	c	r	Common yellowthroat*	c	c	c	r
American robin*	a	c	a	u	Yellow-breasted chat*	o	o	o	
Wood thrush*	u	u	o		Hooded warbler	r			
Hermit thrush	c		c	r	Wilson's warbler	c		c	
Swainson's thrush	c		c		Canada warbler	c		c	
Gray-cheeked thrush	u		u		American redstart*	c	r	c	
Veery*	u		o		House sparrow*	c	c	c	c
Eastern bluebird*	o	o	o	o	Bobolink*	u	u	u	
Blue-gray gnatcatcher	c		c		Eastern meadowlark*	u	u	u	r
Golden-crowned kinglet	c		c	u	Western meadowlark*	u	u	u	
Ruby-crowned kinglet	c		c	r	Red-winged blackbird*	a	a	a	u
Water pipit	u		u	x	Northern oriole*	c	u	u	
Cedar waxwing*	c	u	c	u	Rusty blackbird	c		c	u
Northern shrike				r	Brewer's blackbird	r		r	r
Loggerhead shrike*	r	r	r	r	Common grackle*	a	a	a	u
Starling*	a	a	a	a	Brown-headed cowbird*	c	c	c	u
White-eyed vireo	o		o		Scarlet tanager	c		u	
Yellow-throated vireo*	o		o		Summer tanager	r			
Solitary vireo	u		u		Cardinal*	c	c	c	c
Red-eyed vireo*	c	c	c		Rose-breasted grosbeak	c		c	
Philadelphia vireo	u		u		Indigo bunting*	c	c	c	
Warbling vireo*	c	c	c		Dickcissel*	u	u	u	
Black-and-white warbler	c		c		Evening grosbeak	o		o	o
Prothonotary warbler*	u	u	u		Purple finch	u		u	u
Worm-eating warbler	r		x		Common redpoll	o		o	o
Golden-winged warbler	u		u		Pine siskin	u		u	o
Blue-winged warbler	u		u		American goldfinch*	c	c	c	u
Tennessee warbler	c		c		Rufous-sided towhee*	c	c	c	u
Oranged-crowned warbler	o		o	x	Savannah sparrow*	c	c	c	
Nashville warbler	c		c		Grasshopper sparrow	o	o	o	
Northern parula	o		o		Henslow's sparrow	r			
Yellow warbler*	c	c	c		Sharp-tailed sparrow	r		r	
Magnolia warbler	c		c		Vesper sparrow*	u	u	u	
Cape May warbler	c		c		Dark-eyed junco	c		c	u
Black-throated blue warbler	c		c		Tree sparrow	c		c	c
Yellow-rumped warbler	a		a	r	Chipping sparrow*	u	u	u	
Black-throated green warbler	c		c		Field sparrow*	u	u	u	r
Cerulean warbler	u		o		White-crowned sparrow	c		c	u

Table 52. Bird List of Ottawa National Wildlife Refuge Complex, Ohio/1 (continued)

	S	s	F	W
Fox sparrow	c		c	r
Lincoln's sparrow	u		u	x
Swamp sparrow*	c	r	c	o
Song sparrow*	c	c	c	c
Lapland longspur	o		o	o
Snow bunting	c		c	c

Accidental Bird Sightings

Red-throated loon
Gannet
Wood stork
American flamingo
Brant
Bar-headed goose
Fulvous whistling duck
Harlequin duck
King eider
Gyrfalcon
Bobwhite
Yellow rail
Black rail
Wilson's plover
Purple sandpiper
Long-tailed jaeger
Laughing gull
Little gull
Blacked-legged kittiwake
Least tern
Grove-billed ani
Western kingbird
Black-billed magpie
Boreal chickadee
Bewick's wren
Townsend's solitaire
Bohemian waxwing
Townsend's warbler
Yellow-throated warbler
Kentucky warbler
Orchard oriole
Yellow-headed blackbird
Black-headed grosbeak
Hoary redpoll
Red crossbill
White-winged crossbill
Le Conte's sparrow
Bachman's sparrow
Clay-colored sparrow
Black-chinned sparrow
Harris' sparrow

1/ From Department of the Interior, U. S. Fish and Wildlife Service (1978)

Table 53. State endangered bird species occurring in the western Lake Erie area.

Name	Occurrence
American peregrine falcon (*Falco peregrinus anatum*)	Regularly observed, but uncommon spring migrant
Sharp-shinned hawk (*Accipiter striatus velox*)	Regularly observed, but uncommon spring migrant
Bald eagle (*Haliaeetus leucocephalus*)	Rare to uncommon migrant, breeds in northern Ohio
King rail (*Rallus elegans elegans*)	Rarely observed, breeds in sedge marshes
Upland sandpiper (*Bartramia longicauda*)	Rare migrant and rare breeder
Common tern (*Sterna hirundo*)	Breeds on Toledo Harbor Dike
Kirtland's warbler (*Dendroica kirtlandii*)	Rarely observed, spring migrant

Table 54. Bald eagle nesting data for Ohio from 1973 to 1979[1]

	1973	1974	1975	1976	1977	1978	1979
No. of breeding pairs	7	6	5	5	6*	5	4
No. of productive nests	2	2	2	1	1	1	3
% nest success	14	33	40	20	20	20	80
No. of young fledged	2	2	3	2	1	1	3
No. of young/successful nest	1.00	1.00	1.50	2.00	1.00	1.00	1.00
No. of young/occupied nest	.29	.33	.60	.40	.20	.20	.75

* One of the six nests was found in Ashtabula County.

1/ From Madsen (1977) and D. Case of ODNR (pers. comm.)

Table 55. Waterfowl Territorial Pairs on the Magee Marsh, 1953-1964/1

	Number of Mated Pairs											
	'53	'54	'55	'56	'57	'58	'59	'60	'61	'62	'63	'64
Mallard	31	27	24	43	33	29	21	48	62	69	72	70
Black duck	9	13	6	8	9	6	6	19	28	9	15	14
B-w teal	10	9	7	11	9	11	48	50	65	102	125	127
G-w teal		1								2		
Wood duck	4	8	21	11	16	5	14	18	39	26	43	22
Gadwall			1							2	1	1
Canada goose			1									
Widgeon										2	3	3
Shoveler								2	2	1	4	3
Pintail								2	3		3	2
Redhead									4	3	11	4
Ruddy duck									1	1		
Mallard x Black										3		2
Total	54	58	59	73	66	51	89	139	204	219	277	251

1/ From Table 2, page 175, of Bednarik and Thomson (1965)

Table 56. Estimated waterfowl breeding populations on selected Lak Erie marshes

Study:	Campbell(1940)/1	Anderson(1949)/2	Andrews(1952)/3	
Name / # of Birds:	1940	1949	1951	1952
Mallard	200		53	50
Black duck	400		13	14
Mallard x black duck	-		0	1
Blue-winged teal	150		18	9
Wood duck	small number		11	9
Pintail	-		2	0
Other	occasional		-	-
Total	750+	183	97	83

1/ Study conducted over 7-8 square miles in Lucas County.

2/ Study conducted over 2,272 acres in southwestern Lake Erie area; no breakdown by species available.

3/ Study conducted over 1,000 acres at Winous Point Marsh.

Table 57. Estimates of waterfowl nesting pair densities in selected marshes of southwestern Lake Erie

Year	Nesting Pair Densities	Source	Study Area
1940	45 ± 5 prs./sq. mi.	Campbell (1940)	7-8 sq. mi. in Lucas County
1949	51.5 prs./sq. mi.	Anderson (1949)	2,272 acres of selectively sampled marshes
1950	45.1 prs./sq. mi.	Anderson (1951)	2,272 acres of selectively sampled marshes
1951	48.2 prs./sq. mi.	Anderson (1952)	2,272 acres of selectively sampled marshes
1951	62 prs./sq. mi.	Andrews (1952)	1,000 acres of Winous Point Marsh
1952	53 prs./sq. mi.	Andrews (1952)	1,000 acres of Winous Point Marsh

Table 58. A comparison of 1951-1952 waterfowl breeding pair densities population and estimates in two southwestern Lake Erie marshes

Period	Pair Densities	Study Area	Estimated Breeding Population	Source
1951-1952	1 pr/10 acres	1,000 acres (Winous Point Marsh)	3,000 pairs	Andrews (1952)
1951-1952	1 pr/40 acres	1,960 acres (Magee Marsh)	750 pairs	Bednarik (1965)
1951-1952	1 pr/25 acres	30,000 acres	12,000 pairs	an average

Table 59. Waterfowl nesting success and brood data for Winous Point Marsh in 1951 and 1952[1]

	Number of Nests Established	Number of Nests Successful	Percentage of Nests Successful	Number of Broods Estimated	Number of Young Fledged
1951	74	5	7%	20	68
1952	83	14	17%	35	124
Total	157	19	12% Avg.	55	192

1/ Data taken or calculated from Andrews (1952).

Table 60. Waterfowl nesting success data by species in Winous Point Marsh, 1951 and 1952 1/

	Number of Nests Established	% of Total Nests Established	Number of Nests Successful	% Successful of Nests Established by Species
Mallard	99	63%	13	13%
Black duck	16	10%	2	13%
Unidentified (mallard or black duck)	19	12%	1	5%
Blue-winged teal	13	8%	1	8%
Wood duck	9	6%	2	22%
Pintail	1	1%	0	0%
	157	100%	19	12% Avg.

1/ From Andrews (1952)

Table 61. Common gallinule population estimates for the major southwestern Lake Erie marshes given in breeding pairs[/1]

Marsh	No. of Pairs
Navarre Marsh	302 ± 73
Metzger State Wildlife Area	46 ± 22
Darby Marsh	58 ± 40
Ottawa National Wildlife Refuge	71 ± 36
Magee Marsh State Wildlife Area	76 ± 23
Bay View Shooting Club	58 ± 22
Cedar Point Marsh	479 ± 225
Toussaint Shooting Club	90 ± 79
Toussaint Creek State Wildlife Area	9
Ottawa Shooting Club	5
Winous Point Shooting Club	4
Total	1,198 ± 520

1/ From Table 1 of Brackney (1979)

Table 62. Colonial nesting birds of the southwestern Lake Erie area and Lake Erie islands

Common Name	Scientific Name	Abbreviations Used in Table 64
Great blue heron	*Ardea herodias*	GBH
Great egret	*Casmerodius albus*	GE
Black-crowned night heron	*Nycticorax nycticorax*	BCNH
Cattle egret	*Bubulcus ibis*	CE
Herring gull	*Larus argentatus*	HG
Ring-billed gull	*Larus delawarensis*	RBG
Common tern	*Sterna hirundo*	CT
Louisiana heron	*Hydranassa tricolor*	LH
Little blue heron	*Florida caerulea*	LBH

Table 63. Number of breeding pairs of Lake Erie colonial nesting birds by species during 1976 and 1977[1/]

Species	1976	1977
Herring gull	1,347	1,210
Ring-billed gull	5,040	6,993
Common tern	77	283
Great blue heron	3,305	2,586
Black-crowned night heron	3,000	3,000
Great egret	231	224
Total	13,000	14,296

1/ From Table 31 of Scharf (1978); this information includes estimates from the Lake St. Clair and Detroit River areas.

Table 64. Number of colonial bird nests by location and species

Location	Number of Nests 1976	1977	1978	1979
Toledo Harbor Dike	6 HG* 77 CT (Scharf, 1978)	13 HG 59 RBG 263 CT (Scharf, 1978)	?	?
West Sister Island	1600 GBH 200 GE 3000 BCNH 150-200 HG (Scharf, 1978)	1600 GBH 200 GE 3000 BCNH 150-200 HG (Scharf, 1978)	1 LH** 1 LBH** 20 CE 1167 GBH 100 GE 600-1000 BCNH 299 HG (R.W.Paris,1979)	13+ CE 950 GBH 50 GE (B.Hoffman,pers.comm.)
Winous Point	1671 GBH (Grau & Bittner, 1978)	946 GBH (Grau & Bittner, 1978)	no count available (B.Meeks,pers.comm.)	no count available (B.Meeks, pers.comm.)
Moxley Marsh	39 GBH (Grau & Bittner, 1978)	87 GBH (Grau & Bittner, 1978)	131 GBH (Grau & Bittner, 1978)	no count available (Grau & Bittner, 1978)
Rattlesnake	72 HG (Grau & Bittner, 1978)	56 HG (Grau & Bittner, 1978)	?	?
Stave Island	130 HG (Scharf, 1978)	78 HG (Scharf, 1978)	?	90 HG (B.Hoffman,pers.comm.)
Green Island	6 GH (Scharf, 1978)	33 HG (Scharf, 1978)	?	?
Total	6976	6515	Insufficient data	Insufficient data

Name	1976	1977	1978	1979
Great blue heron	3310	2633	1278+	950+
Great egret	200	200	100	50+
Black-crowned night heron	3000	3000	600-1000	?
Cattle egret	0	5	20	13+
Herring gull	364-414	330-380	299+	90+
Ring-billed gull	0	59	?	?
Common tern	77	263	?	?
Louisiana heron	0	0	1	?
Little blue heron	0	0	1	?

* See Table 62 for key to abbreviations

** Pairs seen but nests not found

Table 65. Comparison of colonial bird nesting populations in the southwestern Lake Erie study area and in the entire Lake Erie area

Year	Number of colonial bird pairs: Southwestern Lake Erie Estimate	Total Lake Erie Estimate	Percent of Total Lake Erie Population in Southwestern Lake Erie
1976	6,976	13,000	53.66
1977	6,515	14,296	45.57
Average	6,745	13,648	49.42

Table 66. Waterfowl traffic on fall migration corridors over West Harbor, Ottawa County, Ohio[1/]

Type of Waterfowl	Estimated Traffic on Corridor (No. of Birds)	Degree of Utilization
Diving ducks	251,000 - 500,000	Highest
Dabbling ducks	101,000 - 350,000	Highest
Canada geese	25,000 - 75,000	Moderate
Blue and Snow geese	Estimates not made	Smallest

1/ From Great Lakes Basin Commission (1975c)

Table 67. 1974 observations of waterfowl traffic over the southwest shore of Lake Erie by Karl Bednarik[1]

Type of Waterfowl	Estimated Traffic (No. of Birds)	Time of Observation
Mallard	10,000	October 1974 to January 1975
Ruddy duck	25,000	late November 1974
Black duck	8,000	November to December 1974
Canada goose	15,000	Autumn 1974
Whistling swan	200-300	late February to early March 1974

1/ From Pinsak and Meyer (1976)

Table 68. Peak population dates for various species of waterfowl along the Lake Erie marshes and northwestern Ohio, as compiled from migration data, 1951-1974[1/]

Type of Waterfowl	Lake Erie Marsh Area	Northwest Ohio
Mallard	11/15	12/1
Black duck	11/15	12/1
Baldpate	11/1	11/5
Gadwall	11/15	11/15
Blue-winged teal	10/15	10/15
Shoveler	10/20	11/1
Green-winged teal	10/25	11/1
Wood duck	10/15	10/20
Scaup	11/15	11/20
Redhead	11/15	11/15
Ringneck	11/15	11/15
Pintail	11/1	11/5
Canvasback	11/25	11/25
Ruddy	11/1	11/1
Goldeneye	12/15	12/15
Bufflehead	11/1	11/1
Hooded merganser	11/1	11/5
Common merganser	11/20	11/20
Canada goose	11/1	11/1
Blue goose	11/1	11/1
Snow goose	11/1	11/1
Coots	10/25	11/1
Total Waterfowl	11/15	12/1

1/ From Table 8 of Ohio Department of Natural Resources, Wildlife In-Service Note 328

Table 69. Critical bird nesting and migration areas of the southwestern Lake Erie area

Area	Nesting Areas	Migration Areas	Remarks
Ottawa National Wildlife Refuge Complex			
Ottawa NWR, Ottawa Division	Eagle	Waterfowl, shorebird, passerine	
Ottawa NWR, Darby Marsh Division	Waterfowl	Waterfowl, shorebird, woodcock, passerine, hawk	
Cedar Point NWR	Eagle	Waterfowl, shorebird, woodcock, passerine, hawk	
West Sister NWR	Blue & night heron, great & cattle egret	---	
Magee Marsh State Wildlife Area	Eagle	Waterfowl, shorebird, passerine, hawk	
Winous Point Shooting Club Marsh*	Eagle	Waterfowl, shorebird, woodcock, passerine, hawk	
Ottawa Shooting Club Marsh*	Eagle	Waterfowl, shorebird, passerine, woodcock, hawk	
East Harbor	--	Waterfowl	
Middle Harbor	--	---	Resting area for migrating waterfowl
Starve Island	Herring gull	---	
Green Island	Eagle	Passerine	
South Bass Island	--	Passerine	Cedar roost west of Put-in-Bay, owned by Hineman Winery, is major stopover for blackbirds.
North Bass Island	Night heron, waterfowl	Waterfowl, shorebird	Major blackbird, robin, and bluejay flights stopover here from Point Pelee.
Ballast Island	Herring gull, ring-billed gull	---	
Kelleys Island Marsh	Waterfowl	Waterfowl, passerine	Nearly filled in.

* Not in study area, but included due to their proximity to other areas.

/1 Modified from Scharf (1971) Critical Nesting and Migration Areas. In: Great Lakes Basin Commission, Appendix 12: Shore Use and Erosion.

Table 70. Mammals of the southwestern Lake Erie area and their habitats

Name	Habitat Preference
Opossum Didelphis marsupialis	Wooded areas along streams, around lakes, and in swamps
Eastern mole Scalopus aquaticus	Grassy prairie, oak openings, and farming districts, prefers sandy soils and loam
Starnose mole Condylura cristata	Swamp, bogs, and low, wet meadows
Masked shrew Sorex cinereus	Brushy and grassy areas near water, also woodlands with logs and litter
Least shrew Cryptotis parva	Open grass and brush
Shorttail shrew* Blarina brevicauda	Habitats varied, but most common in heavy forests and low, damp, swampy areas
Little brown myotis* Myotis lucfugus	May live in hollow trees, beneath loose bark, in caves, about buildings or loose siding by day; flying over fields, lakes, and in forests by night
Indiana myotis Myotis sodalis	Winters in caves; beneath loose bark along small streams in summer
Keen myotis Myotis keeni	Forested areas
Silver haired bat Lasionycteris noctivagans	Forested areas, preferably along streams and lakes
Eastern pipistrel Pipistrellus subflavus	Caves, buildings, and crevices in rocks or trees
Big brown bat Eptesicus fuscus	Buildings, hollow trees, caves, or crevices in rock cliffs
Evening bat Nycticeius humeralis	Wooded areas and buildings by day
Red bat Lasiurus borealis	Wooded areas
Hoary bat Lasiurvs cinereus	Forested areas
Raccoon* Procyon lotor	Wooded areas along streams and near lakes where large hollow trees are present
Longtail weasel Mustela frenata	Forests, brushland, and prairies, especially near water
Least weasel Mustela rixosa	Meadows, fields, and possibly woodlands
Mink Mustela vison	Along streams and lakes, especially where wooded

Table 70. Mammals of the southwestern Lake Erie area and their habitats (continued)

Name	Habitat Preference
Badger *Taxidea taxus*	Open country, preferable grassland
Striped skunk *Mephitis mephitis*	Semi-open country with a mixture of woods, brushland, and open grassland, preferably not more than two miles from water
Red fox* *Vulpes fulva*	Broken, sparsely settled country
Gray fox *Urocyon cinereoargenteus*	Forests and fairly open brushland
Woodchuck *Marmota monax*	Forests and heavy brush; in farming districts along creeks and brushy ravines
Thirteen-lined ground squirrel *Citellus tridecemlineatus*	Open grassland, especially golf courses
Eastern chipmunk *Tamias striatus*	Large hardwood forests and semiopen brushland, rarely in swamps
Red squirrel *Tamiasciurus hudsonicus*	Usually coniferous forests, but also in hardwood forests
Eastern gray squirrel* *Sciurus carolinensis*	Large hardwoods, extensive in area
Eastern fox squirrel *Sciurus niger*	Small areas of hardwoods interspersed with open farm land, and wooded streams
Southern flying squirrel *Glaucomys volans*	Wooded areas
Deer mouse*	
*Peromyscus mariculatus bairdi**	Open grass-covered areas, dry upland
Peromyscus maniculatus gracilis	Forested areas
White-footed mouse* *Peromyscus leucopus*	Usually forested and brushy areas, occasionally present in open, grassy areas bordering woods or brush
Southern bog lemming *Synaptomys cooperi*	Low damp bogs or meadows in which there is a heavy growth of grass, usually small local areas
Meadow vole* *Microtus pennsylvanicus*	Moist, low areas with rank growths of grassland and near streams, lakes, and swamps
Pine vole *Pitymys pinetorum*	Deciduous forests and brushy areas where there is a heavy ground cover of either leaves or grass
Muskrat* *Ondatra zibethica*	Marshes, ponds, lakes, and streams, especially with heavy growths of rushes or cattails

Table 70. Mammals of the southwestern Lake Erie area and their habitats (continued)

Name	Habitat Preference
Norway rat* *Rattus norvegicus*	Around places of human habitation
House mouse* *Mus musculus*	Around places of human habitation, although often in fields where there is grain
Meadow jumping mouse *Zapus hudsonius*	Habitat varied but prefers low meadows
Eastern cottontail* *Sylvilagus floridanus*	Brushy areas, edges of swamps, and open woods
Whitetail deer *Odocoileus virginianus*	Border areas between forests and openings

* Noted as occurring on the Lake Erie islands, from Table 45 of Cooper and Herdendorf (1977)

Table 71. Population densities and population estimates for several mammalian species on Magee Marsh in 1967[1]

Species	Population Density	Estimate of Population Numbers
Raccoon	16.0 animals/sq. mi.	52
Opossum	12.0 animals/sq. mi.	39
Mink	7.0 animals/sq. mi.	24
Weasel	1.5 animals/sq. mi.	5
Skunk	12.0 animals/sp. mi.	--
Red fox	4.3 animals/sq. mi. or 0.8 adult/sq. mi.	14

1/ From Bailey (1968)

Table 72. Shoreline land use for Lucas and Ottawa Counties, excluding the Lake Erie islands

	Lucas County/1		Ottawa County/2		Total	
	Miles	% of Total	Miles	% of Total	Miles	% of Total
Marsh	9.0	41	7.8	24	16.8	31
Residential	7.1	32	17.2	52	24.3	44
Industrial	2.3	10	1.0	3	3.3	6
Park	2.0	9	3.0	9	5.0	9
Agricultural, or undeveloped	1.3	6	2.7	8	4.0	7
Woodland	0.4	2	1.2	4	1.6	3
Total	22.1	100	32.9	100	55.0	100

1/ From Table 1 of Benson (1978)

2/ Estimates made from 1967 and 1969 U. S. Geological Survey topographic maps for Ottawa County.

Table 73. 1970 land use survey for Catawba Island and Put-in-Bay Townships

	Catawba Is. Township (acres)	Put-in-Bay Township (acres)
Residential		
1-2 Family	1,[illegible]7	544
Multiple	11	2
Employment Areas and Centers		
Agricultural (General)	1,484	880
Agricultural (Specific)	62	506
Manufacturing	15	16
Extractive	0	1
Commercial	163	191
Governmental & Inst.	12	19
Movement Systems		
Township highways	32	65
County highways	23	27
State highways	46	11
Non-highways R/W	51	55
Recreation and Open Space		
Local community parks	0	11
Non-local recreation & open space	348	332
Wooded areas	59	115
Swamp and Marsh	26	63
Total Area	3,610	2,842

1/ From Table 51 in Cooper and Herdendorf (1977)

Table 74. Visitation and use figures for several management areas from 1974 to 1978

Management Area	1978	1977	1976	1975	1974
Ottawa NWR Complex[1]	100,000				
Metzger Marsh State Wildlife Area/2	Approximately 32,000 fishing trips/year, 3,500 hunting and trapping trips/year, and 2,500 other visitor trips/year.				
Magee Marsh State Wildlife Area and Crane Creek Wildlife Experiment Station/3	33,417	31,013	45,098	33,802	52,348
Toussaint Creek State Wildlife Area/2	No available estimate for fishing trips/year, approximately 2,500 hunting and trapping trips/year, and 800 other visitor trips/year.				
Little Portage River State Wildlife Area/2	Approximately 6,000 fishing trips/year, 4,500 hunting and trapping trips/year, and 1,500 other visitor trips/year.				
Catawba State Park/4	1,790,150	249,163	322,430	483,504	468,202
East Harbor State Park/4	1,612,265	1,488,223	1,348,543	1,473,505	1,320,270
Kelleys Island State Park/4	77,863	135,577	227,110	115,941	59,816
South Bass Island State Park/4	346,075	262,061	308,322	476,572	412,984
Winous Point Shooting Club/5	Approximately 1,500 research use days/year and 300 hunter use days/year.				

/1 From M. Boylan, Outdoor Recreation Planner at Ottawa NWR (pers. comm.)

/2 From L. Cunningham, Wildlife Management Supervisor for Ohio Department of Natural Resources, Division of Wildlife, District 2 (pers. comm.)

/3 *From Table 2 of Monthly Report*, Ohio Department of Natural Resources, Crane Creek Wildlife Experiment Station

/4 From Cooper and Herdendorf (1977) and Ohio Department of Natural Resources, Division of Parks and Recreation (pers. comm.)

/5 From B. Meeks, Wildlife Biologist at Winous Point Shooting Club (pers. comm.)

Table 75. Analysis of visitors of the Sportsmen's Migratory Bird Center, at Magee Marsh Wildlife Area and Crane Creek Wildlife Experiment Station, October 1971 - August 1979

Year	Total Visitors	No. Signing Register	Percent of Total	Number Hunters	Percent Register	Number Fishermen	Percent of Register
1971	37,402	5,817	16%	1,940	33%	2,868	49%
1972	50,028	5,759	11%	1,699	29%	2,682	46%
1973	53,261	5,124	10%	1,556	30%	2,314	45%
1974	52,348	4,047	8%	1,230	30%	2,262	55%
1975	33,802	4,456	13%	1,218	27%	3,825	85%
1976	45,098	6,933	15%	1,746	25%	1,750	25%
1977	31,013	5,321	17%	990	19%	2,060	23%
1978	33,417	4,698	14%	615	13%	1,295	28%
1979	28,413	4,593	16%	747	16%	1,245	27%
Total	377,107	50,842	14%	12,061	24%	21,520	42%

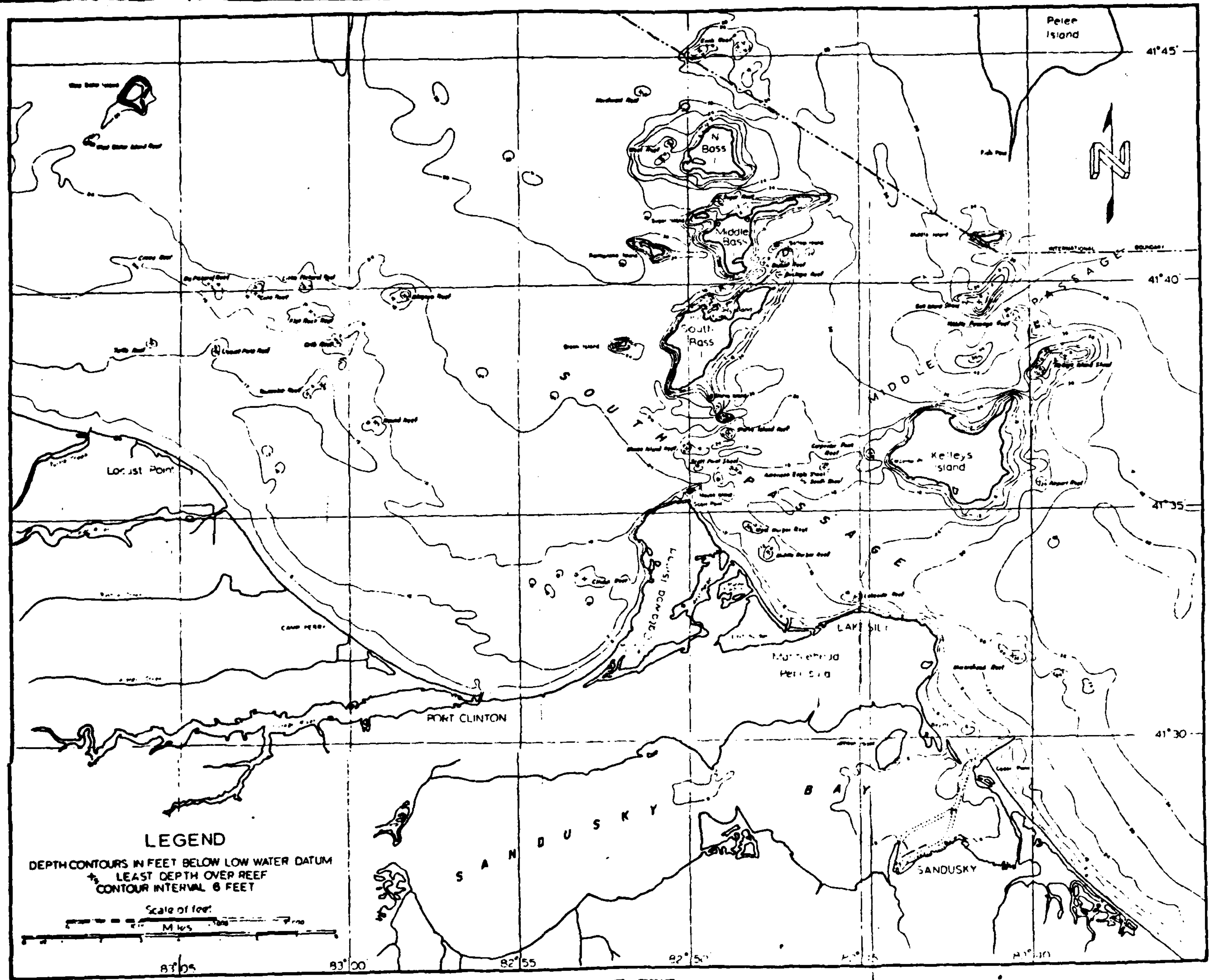


PLATE 1. HYDROGRAPHY OF THE REEF AREA OF WESTERN LAKE ERIE

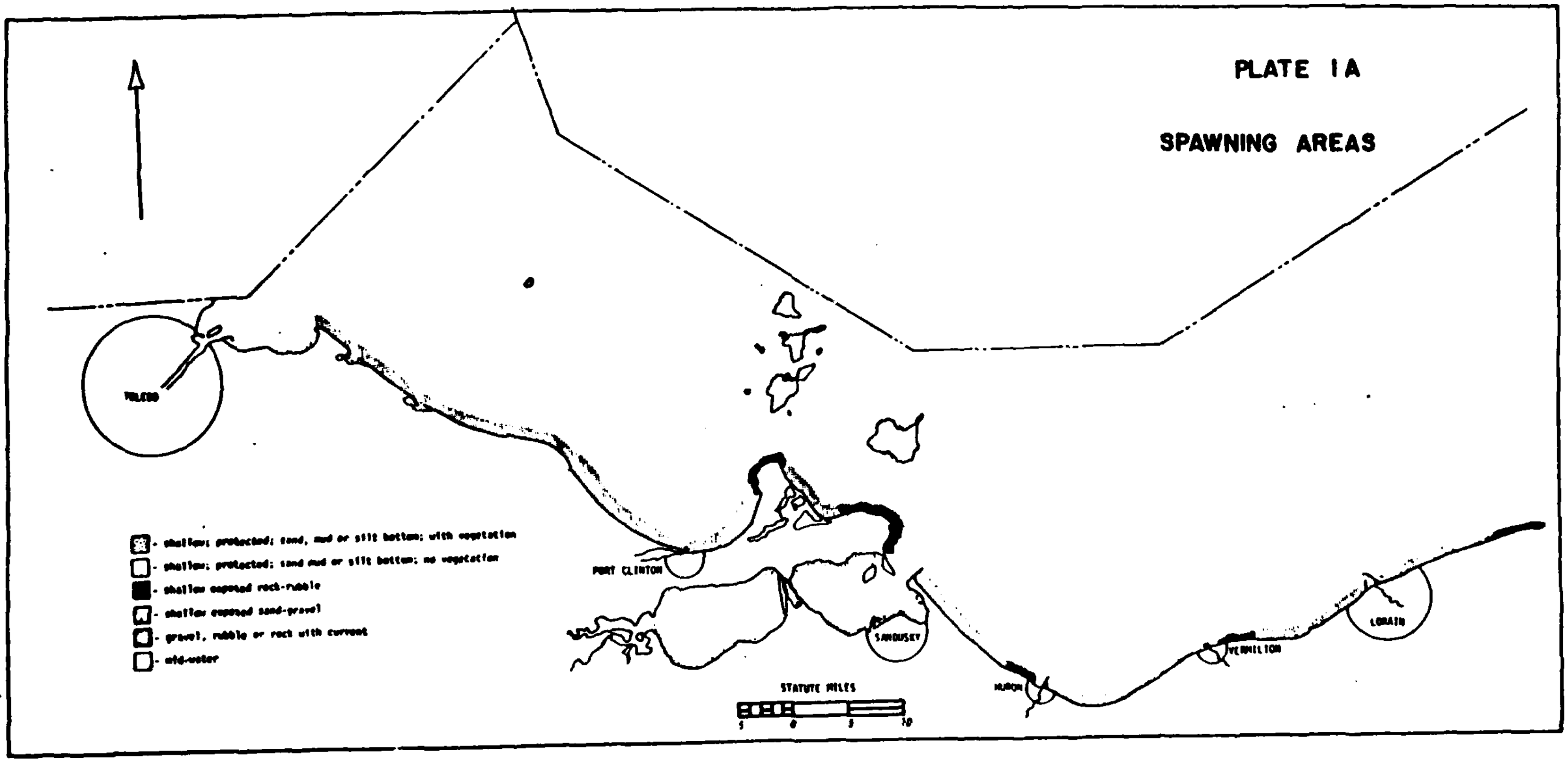


PLATE 1A

SPAWNING AREAS

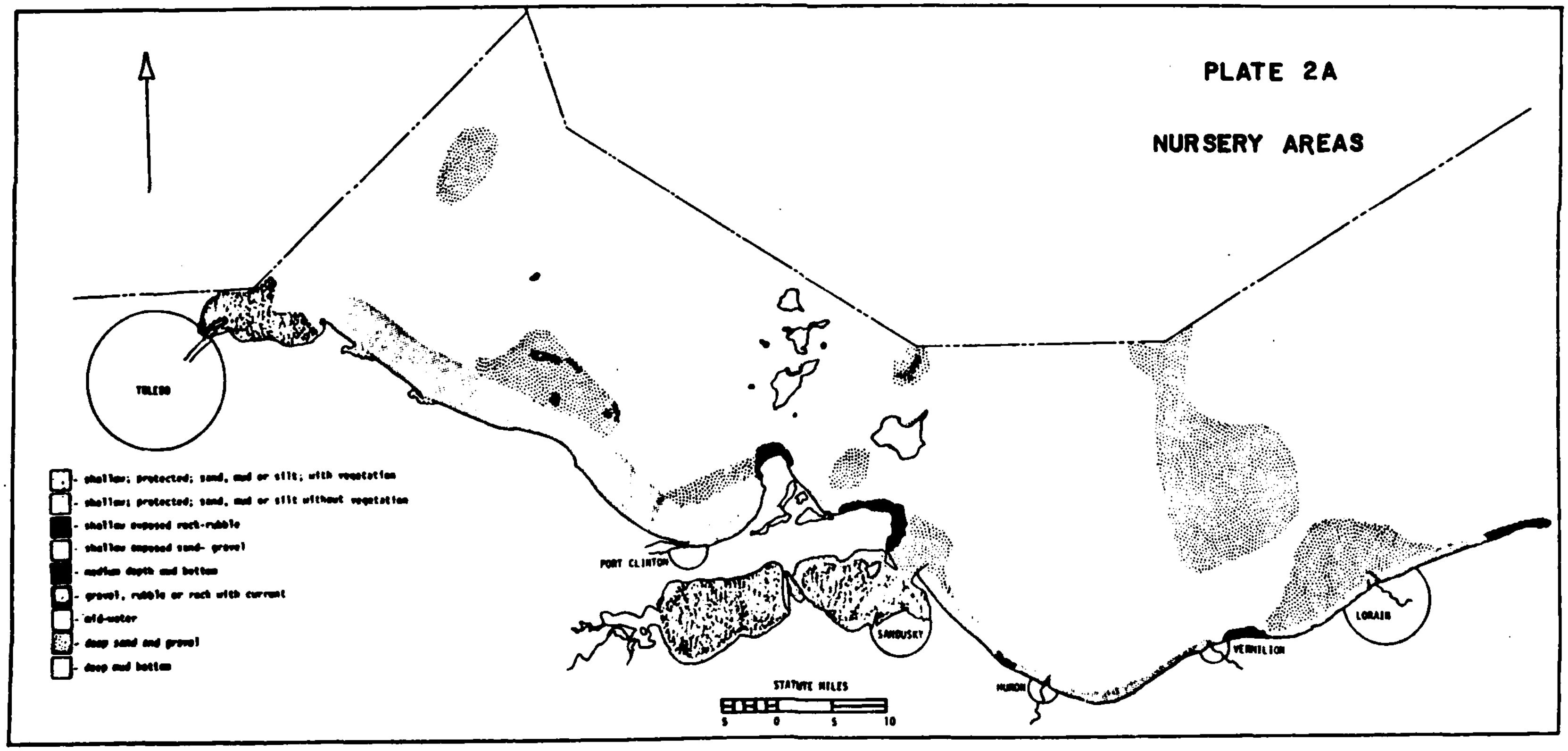


PLATE 2A
NURSERY AREAS
TOLEDO
PORT CLINTON
SANDUSKY
HURON
VERMILION
LORAIN
STATUTE MILES
5 0 5 10
- shallow; protected; sand, mud or silt; with vegetation
- shallow; protected; sand, mud or silt without vegetation
- shallow exposed rock-rubble
- shallow exposed sand- gravel
- medium depth mud bottom
- gravel, rubble or rock with current
- mid-water
- deep sand and gravel
- deep mud bottom

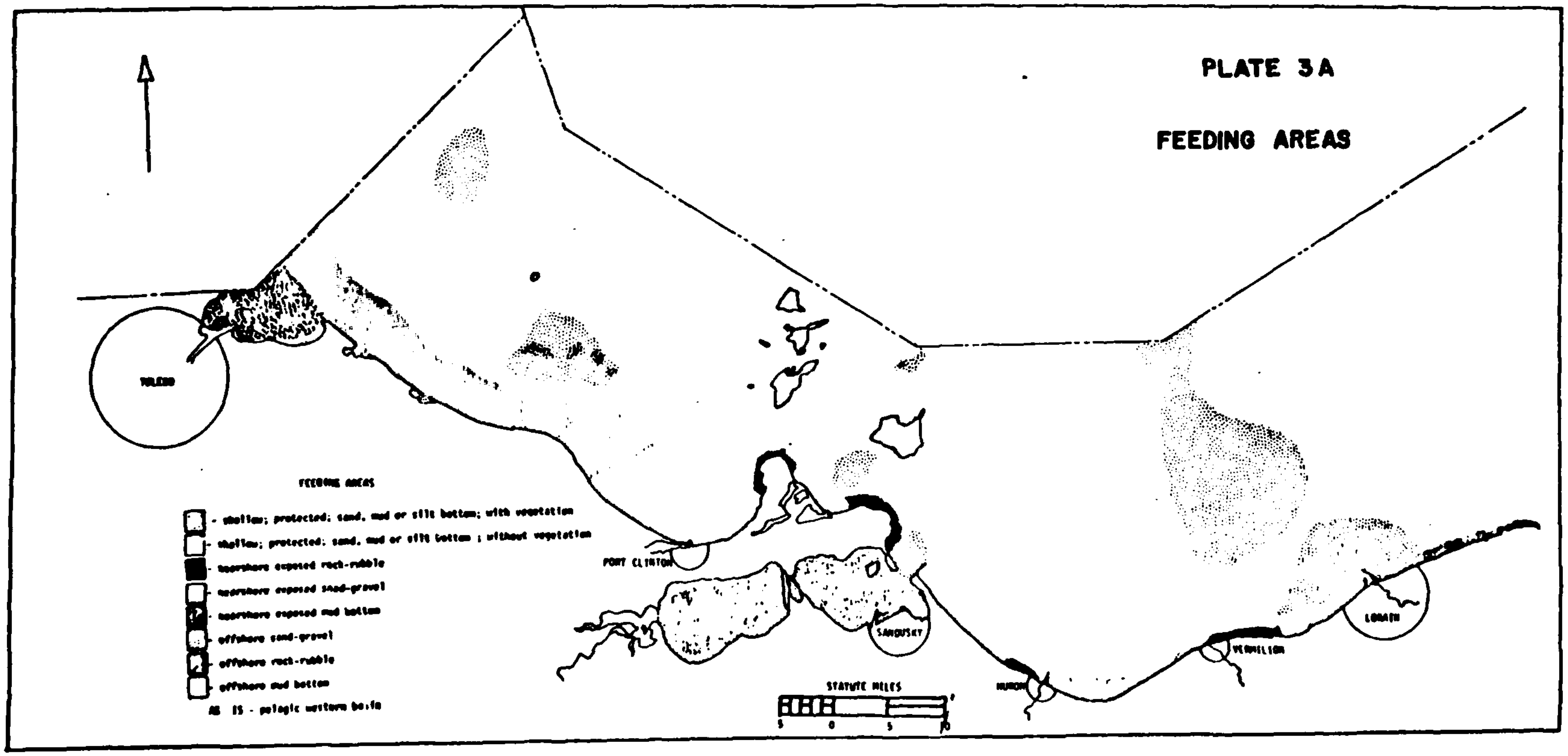
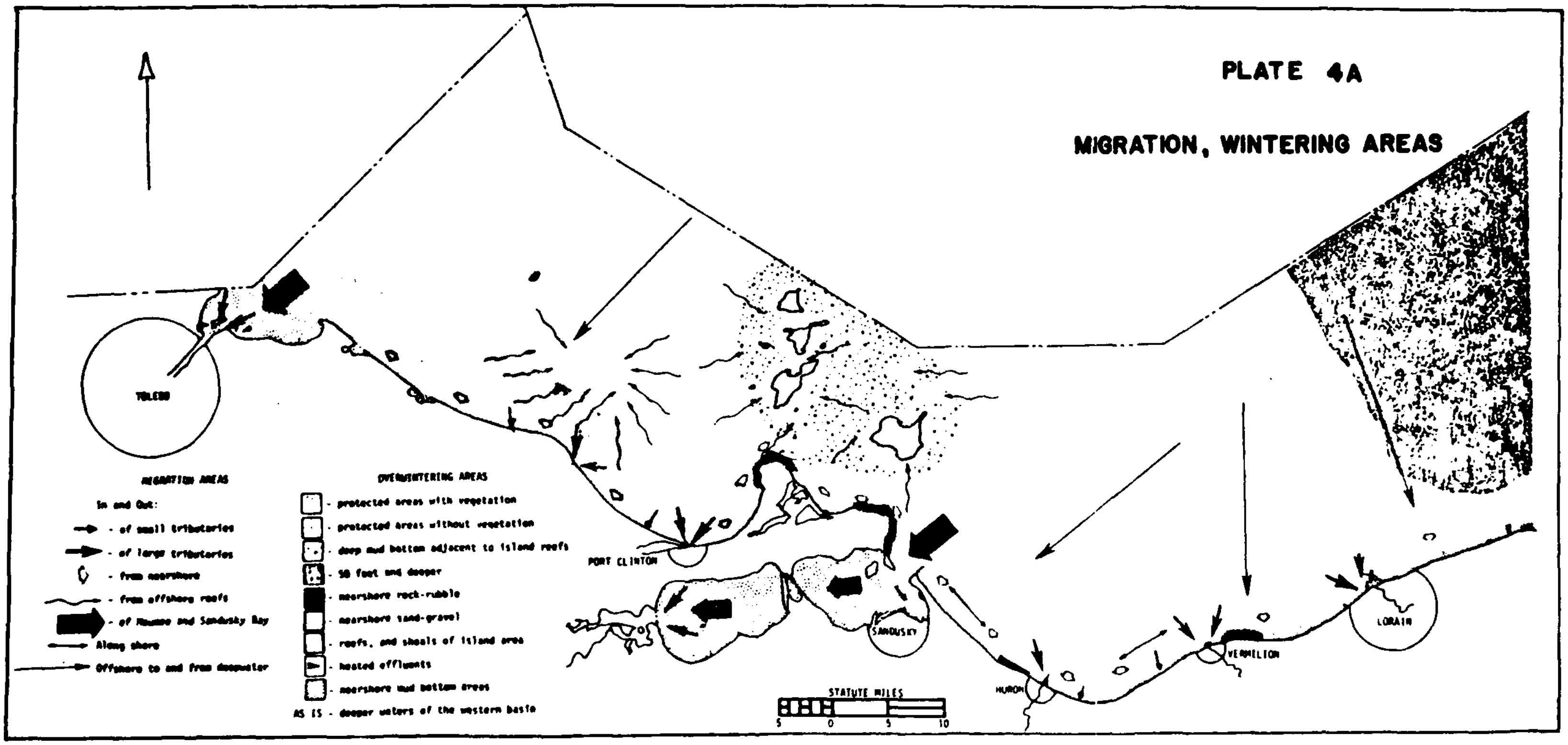


PLATE 3A
FEEDING AREAS
TOLEDO
PORT CLINTON
SANDUSKY
HURON
VERMILION
LORAIN
STATUTE MILES
5 0 5 10
FEEDING AREAS
- shallow; protected; sand, mud or silt bottom; with vegetation
- shallow; protected; sand, mud or silt bottom ; without vegetation
- nearshore exposed rock-rubble
- nearshore exposed sand-gravel
- nearshore exposed mud bottom
- offshore sand-gravel
- offshore rock-rubble
- offshore mud bottom

PLATE 4A

MIGRATION, WINTERING AREAS



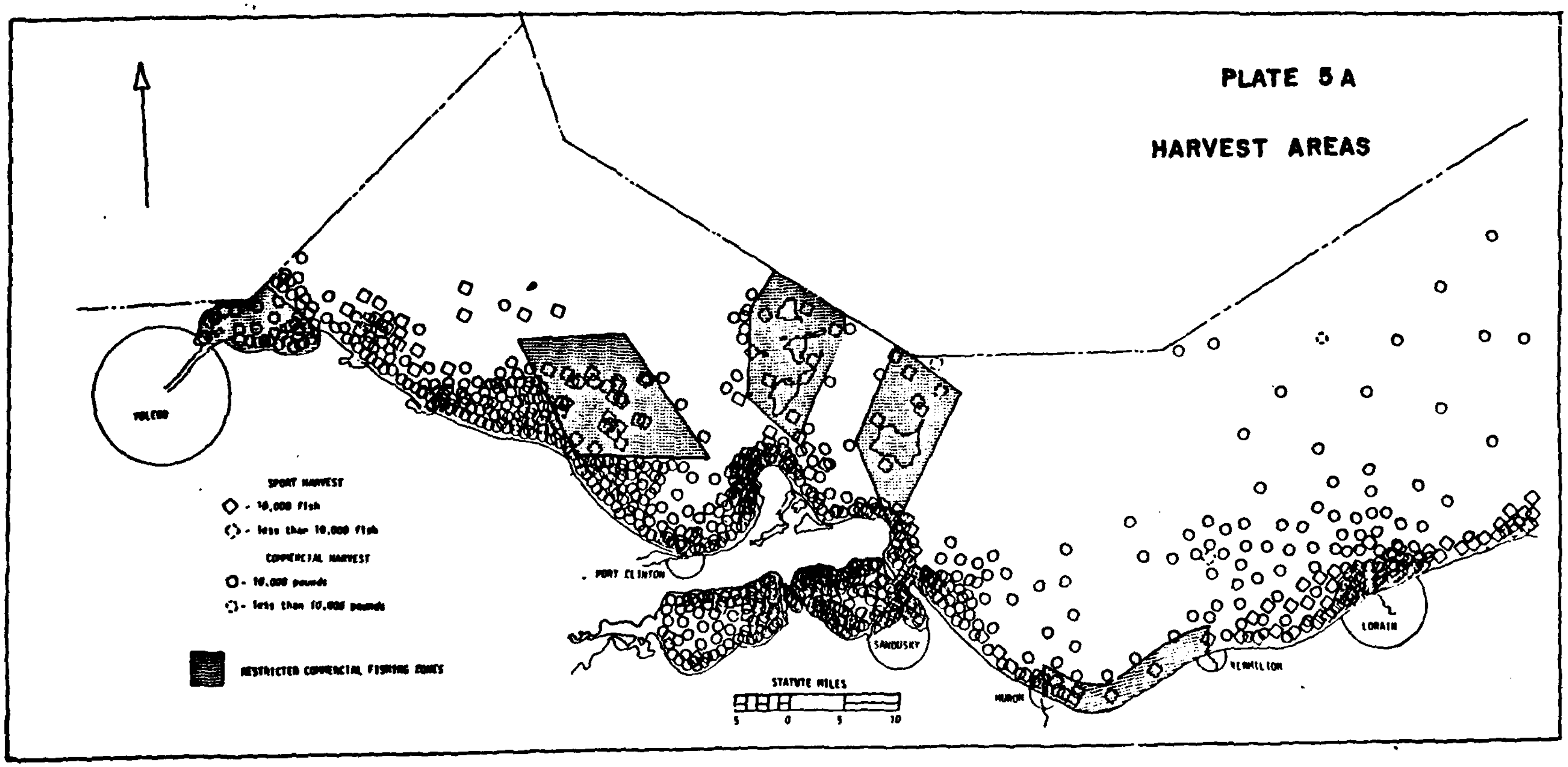


PLATE 5 A
HARVEST AREAS
TOLEDO
PORT CLINTON
SANDUSKY
HURON
VERMILION
LORAIN
STATUTE MILES
5 0 5 10
SPORT HARVEST
- 10,000 fish
- less than 10,000 fish
COMMERCIAL HARVEST
- 10,000 pounds
- less than 10,000 pounds
RESTRICTED COMMERCIAL FISHING ZONES

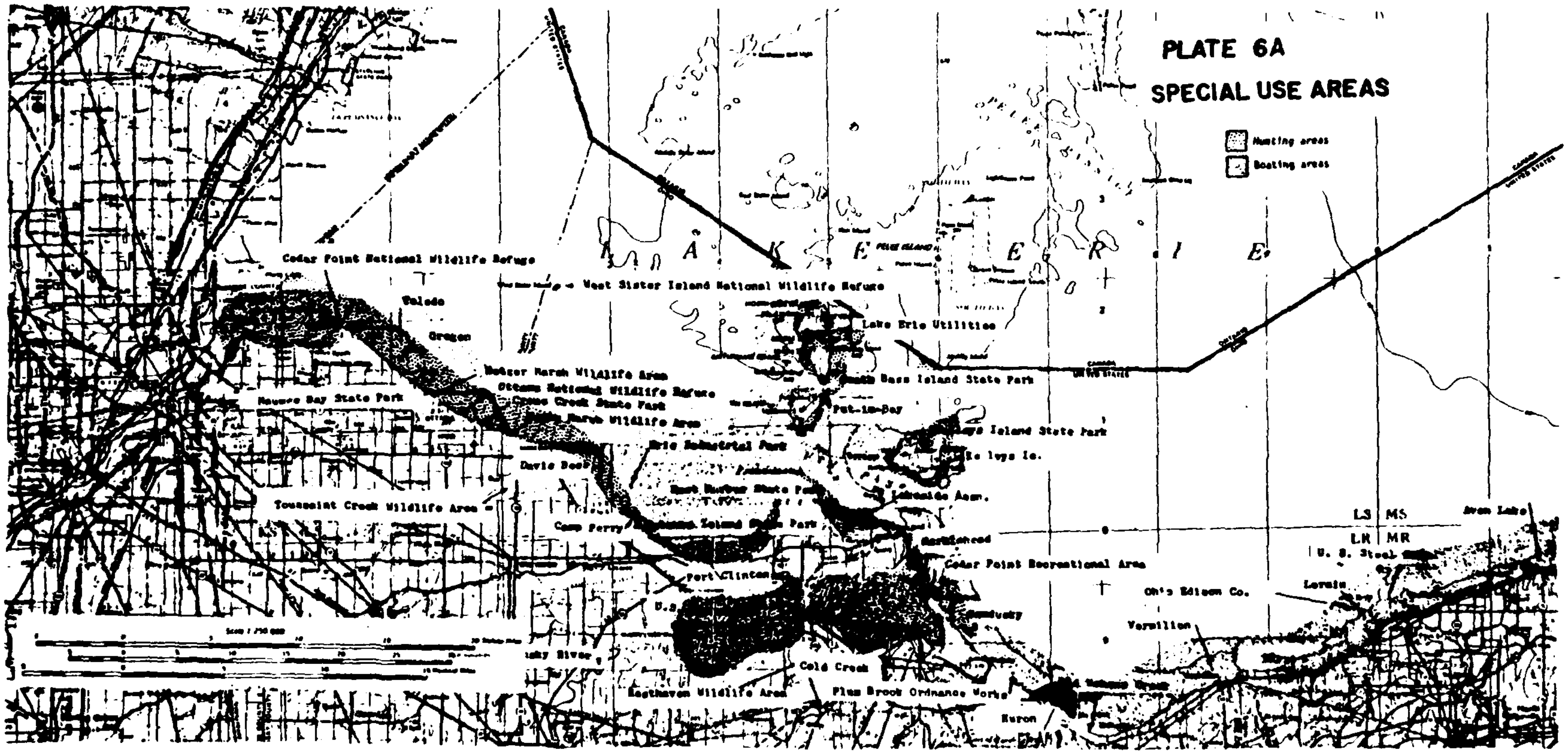
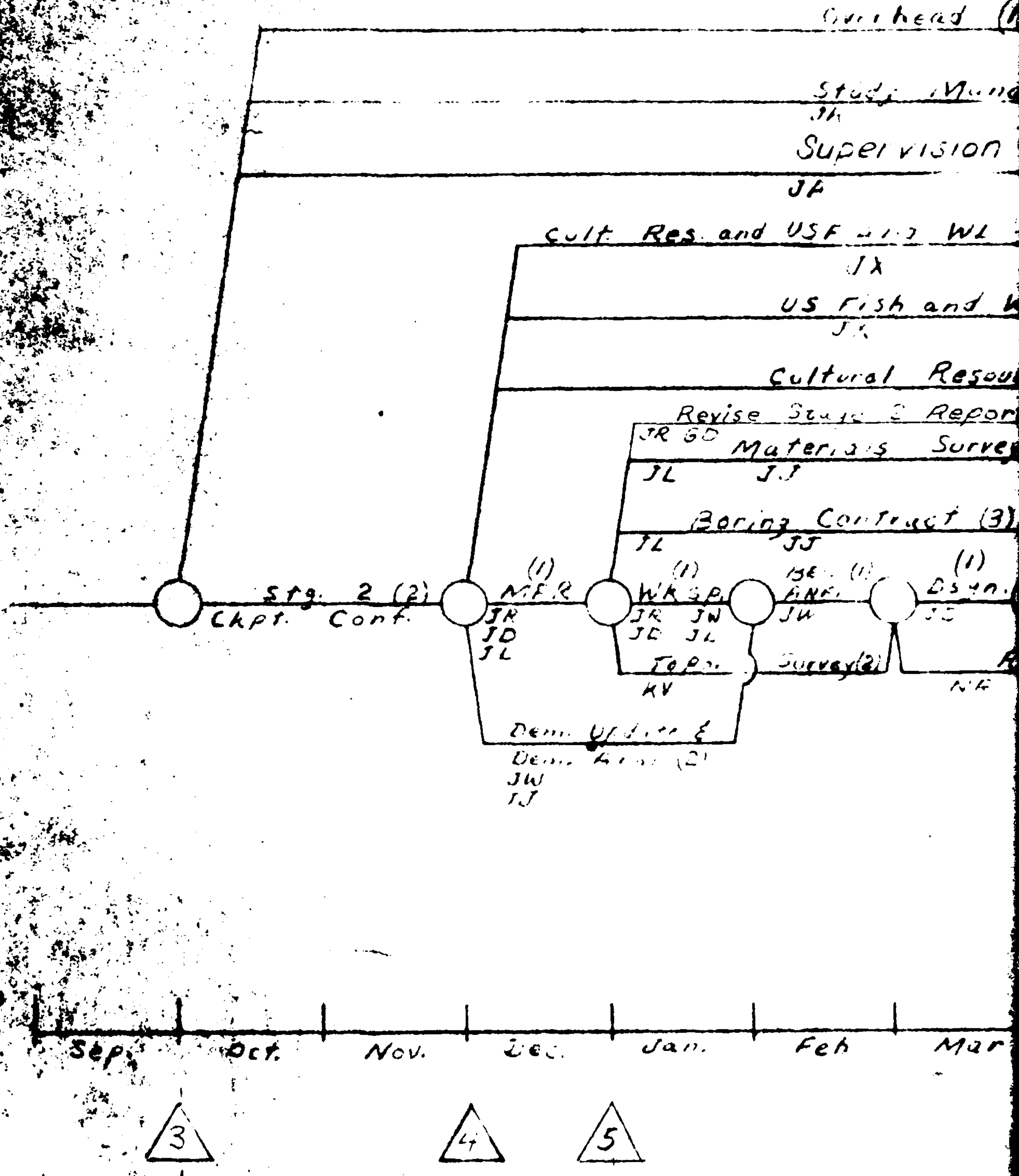


PLATE 6A
SPECIAL USE AREAS
Hunting areas
Boating areas
LAKE ERIE
Cedar Point National Wildlife Refuge
West Sister Island National Wildlife Refuge
Toledo
Oregon
Magee Marsh Wildlife Area
Ottawa National Wildlife Refuge
Crane Creek State Park
Maumee Bay State Park
Lake Erie Utilities
South Bass Island State Park
Put-in-Bay
Kelleys Island State Park
Davis Besse
Toussaint Creek Wildlife Area
Camp Perry
Port Clinton
Marblehead
Cedar Point Recreational Area
Sandusky
Cold Creek
Plum Brook Ordnance Works
Huron
Vermilion
Ohio Edison Co.
Lorain
U. S. Steel
Avon Lake
LS MS
LR MR

APPENDIX F

STUDY FLOW NETWORKS

Exhibit	Description
F1	Study Flow Network for Maumee Bay State Park Interim Report
F2	Study Flow Network for Final Report



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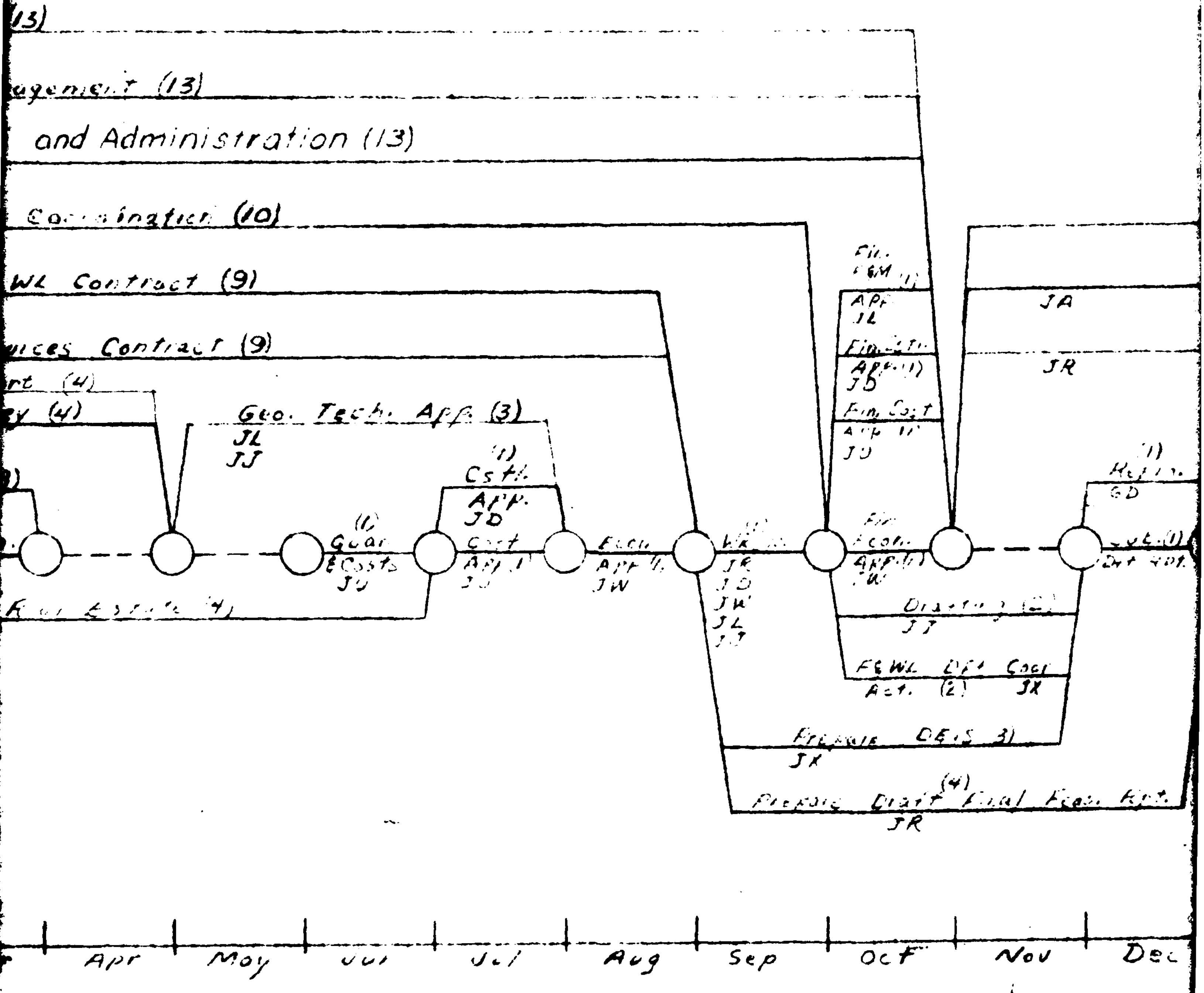
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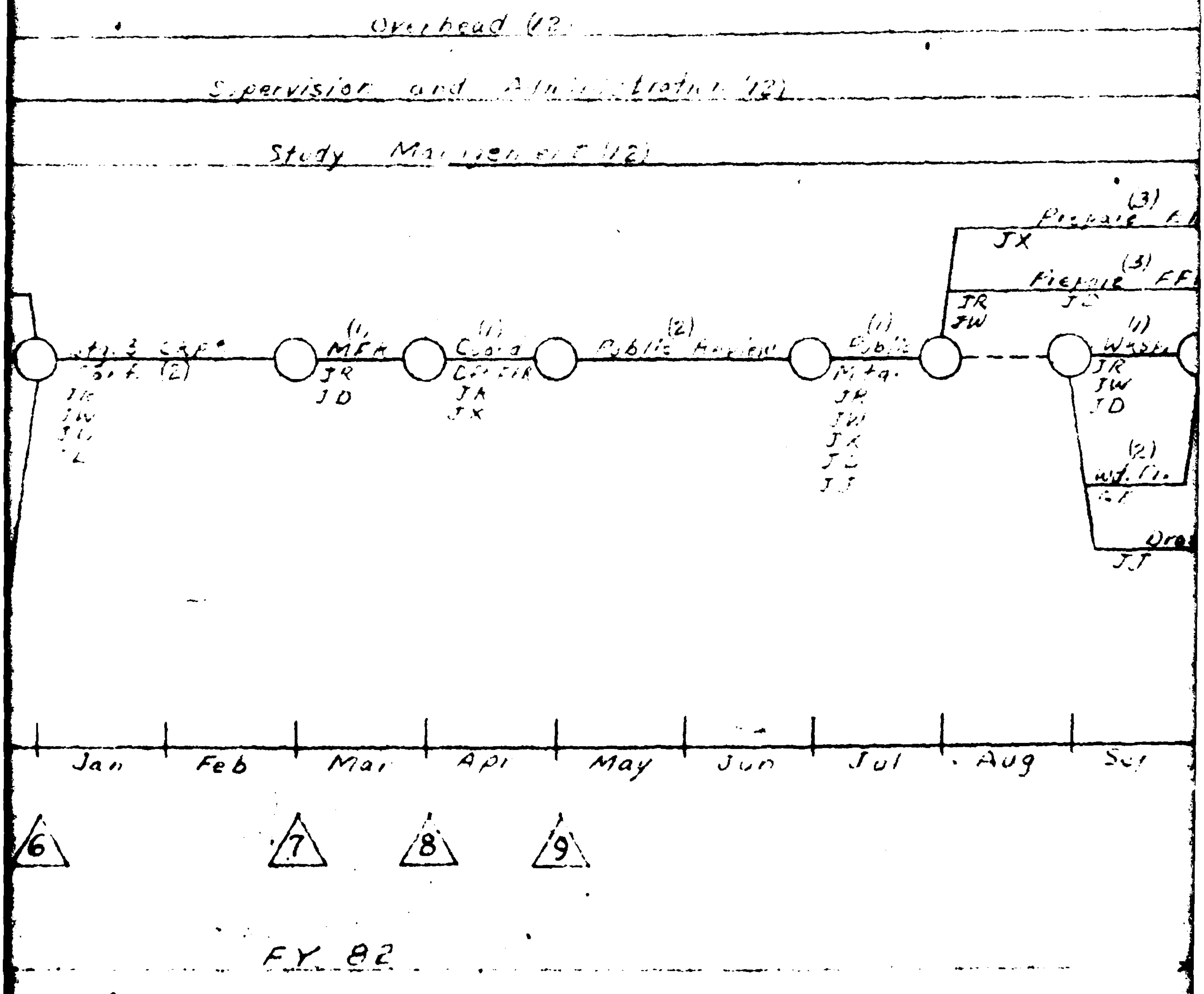
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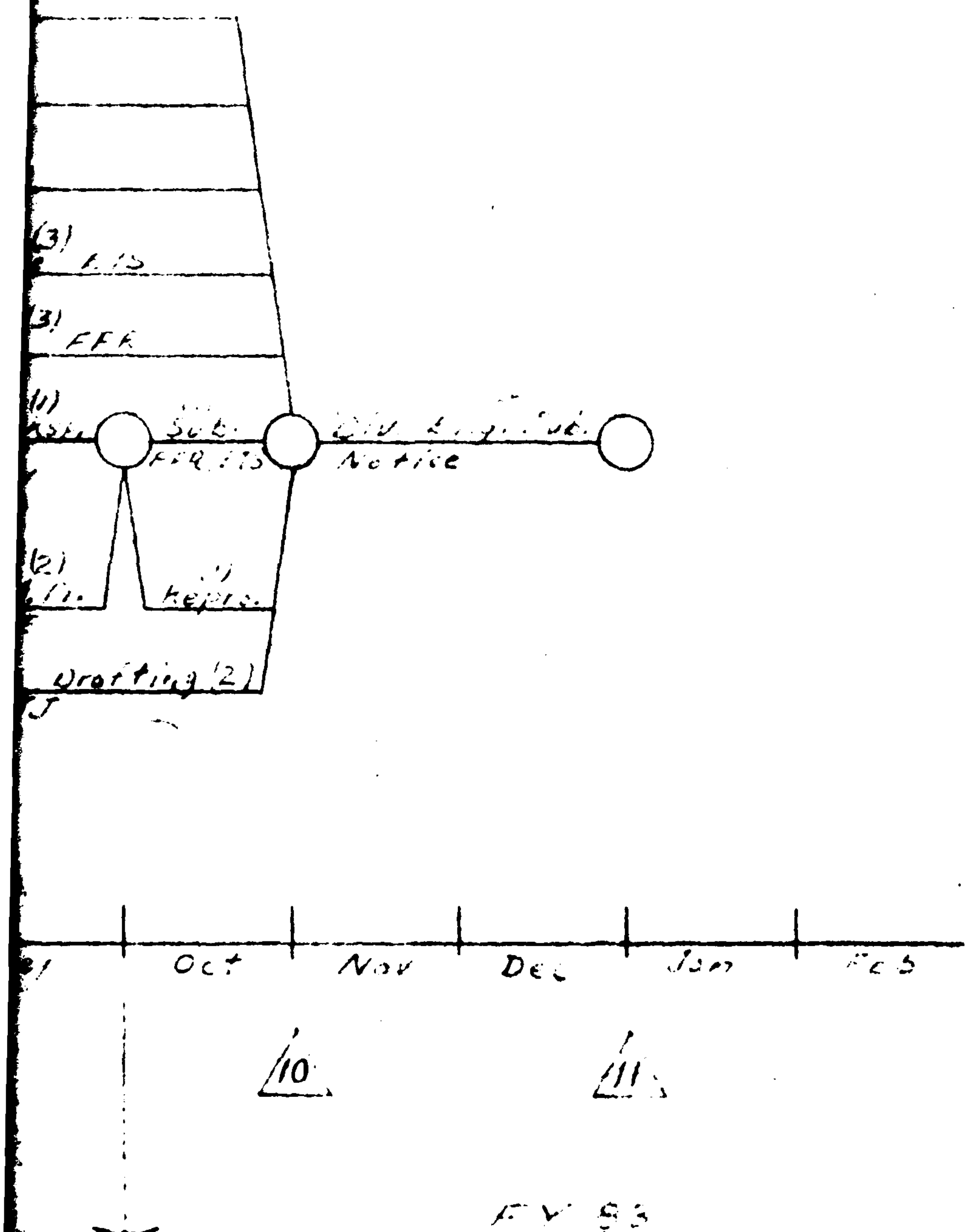

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Feasibility
Prepared

Organizational Elements

Planning	JR
Environmental	JX
Economics	JW
Coastal	JD
Gen. Engr.	JU
F & S	JL
Drafting	JJ
Engineering	JA
Real Estate	NR
Word Proc.	GF
Reproduction	GD
Surveys	KV

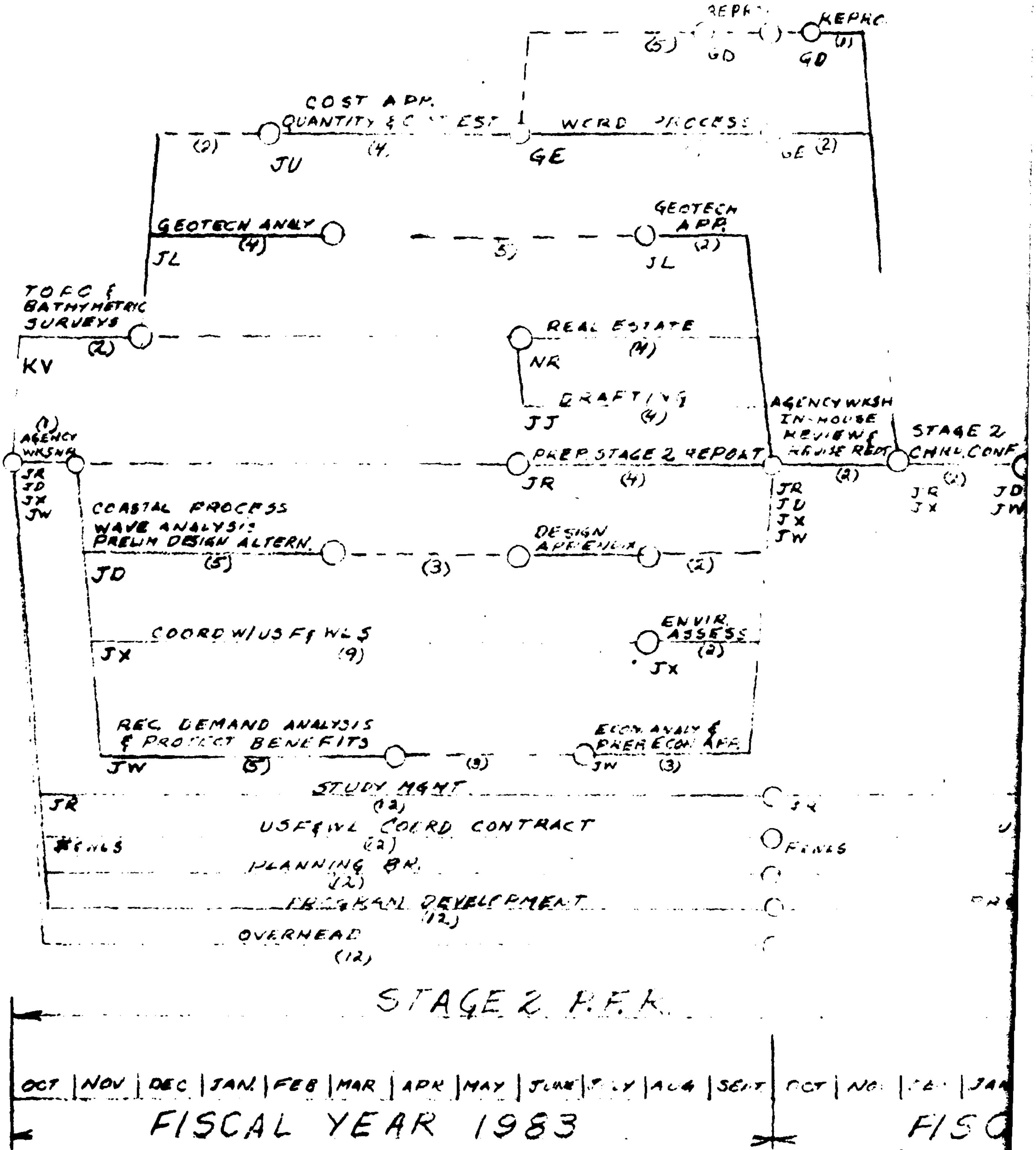
LEGEND

ACTIVITY (2 ELEMENTS)

5 MILESTONE EVENT

Study Flow Network
(CPM)
MAUMEE BAY STATE PARK, OHIO
Feasibility Study
Updated Sept. 80

APPENDIX F



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JD JW
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ENVIR. ASSESS
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JX
REC DEMAND ANALYSIS & PROJECT BENEFITS
JW
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(3)
ECON ANALY & PREP ECON APP.
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STUDY MGMT
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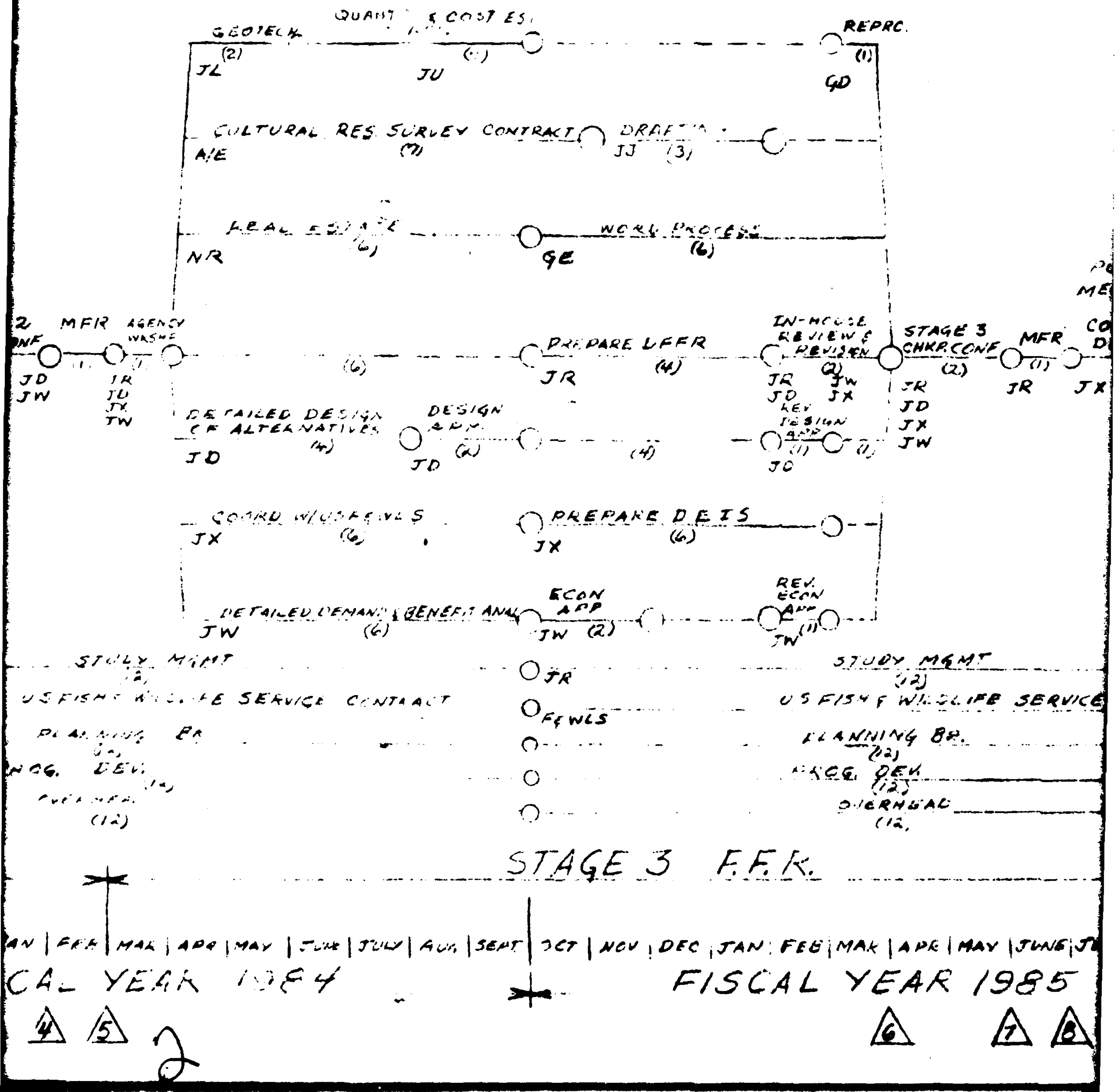

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ORGANIZATIONAL CODE	
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GENERAL ENGRG.	JU
GEOTECHNICAL	JL
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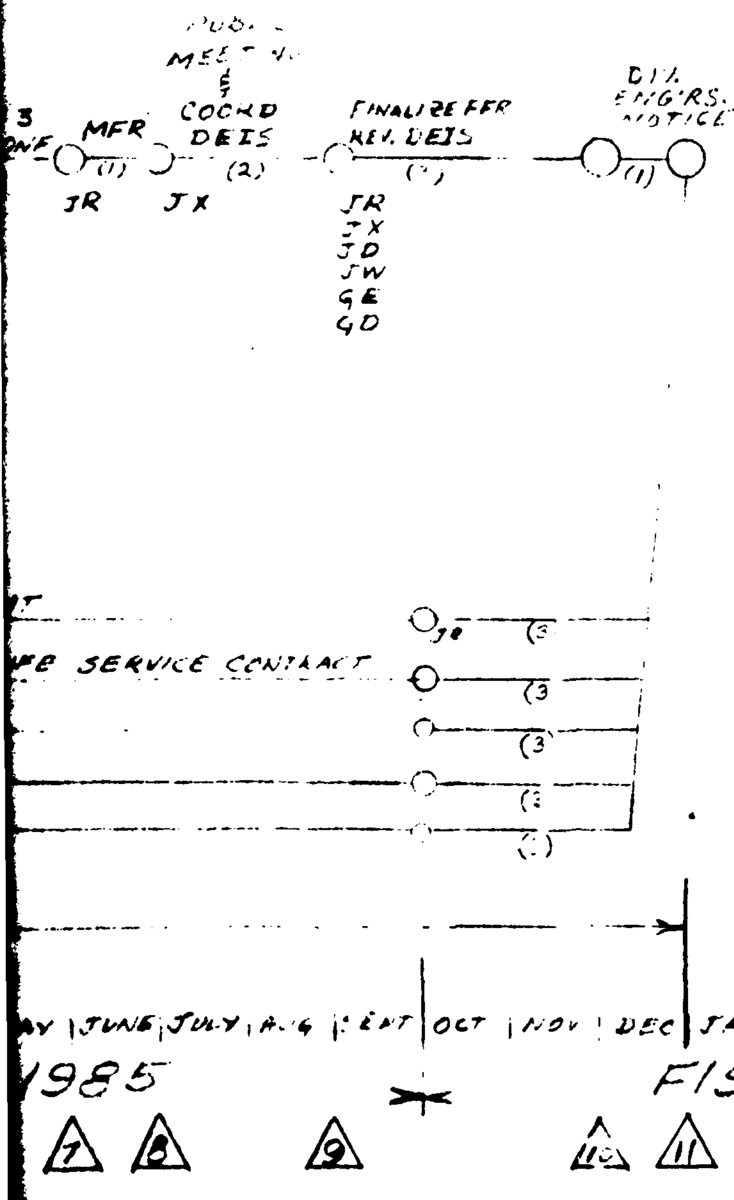
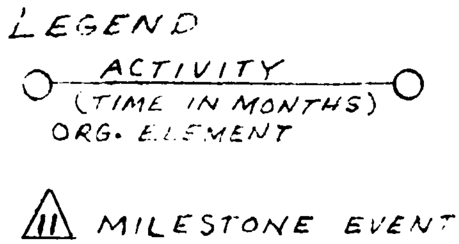
WORD PROCESSING	GE
REPRODUCTION	GD
SURVEYS	KV
PROGRAM DEV	PD
REAL ESTATE	NR
DRAFTING	JJ





WESTERN LAKE ERIE SHORE STUDY

STUDY FLOW NETWORK (CPM) FOR FINAL REPORT

(INCL. EAST HARBOR STATE PARK)

MARCH 1981

PLATE 2, APPENDIX F

APPENDIX G

PUBLIC INVOLVEMENT

Exhibit No.	Description	No. of Pages
G1	11/28/78 News Release	1
G2	Information Packet, 10 and 11 January 1979 Workshop	22
G3	Summary Minutes, 10 January 1979 Workshop	5
G4	Summary Minutes, 11 January 1979 Workshop	4
G5	Trip Report, Field Recon of 2 - 5 October 1978	3
G6	Trip Report, Field Recon of 6 - 8 November 1979	4
G7	Trip Report, Field Recon of 8 - 10 January 1980	8
G8	Summary of Lake Erie Regulation Study Findings; August 1980	8
G9	Trip Report, Field Recon of 21 - 23 January 1981	2
G10	Surveys at Bono, Ohio	2

1776 NIAGARA STREET BUFFALO, N.Y. 14207

NEWS

CORPS OF ENGINEERS

BUFFALO DISTRICT

FOR INFORMATION CONTACT
Ron Hoskins
716/876-5454 (Ext. 2209)

FOR IMMEDIATE RELEASE

November 28, 1978

BUFFALO, N.Y., November 28 - The U.S. Army Corps of Engineers has begun a $1 million study of the feasibility of providing flood and beach erosion protection to the western shoreline of Lake Erie.

The study, which will be conducted by the Corps' Buffalo District, will investigate the Lake Erie shore from Marblehead, Ohio, to the Ohio-Michigan state line and will take about five years to complete.

Included in the study area is the Maumee State Park, which is being developed as a park and wildlife refuge by the Ohio Department of Natural Resources. The existing beach area presently contains approximately 3,500 feet of natural shoreline. A special interim report will be produced on this portion of the study and is scheduled to be ready before the total study is released.

In the first stage of the study the Corps will produce a Reconnaissance Report. This report will outline the course of the study and establish a study schedule. Public meetings and workshops will be held during this phase to obtain citizen views on what problem areas the study should consider.

The completed study report is scheduled to be submitted to Congress in 1982.

- 30 -

EXHIBIT 61

INFORMATION PACKAGE

FOR

WESTERN LAKE ERIE SHORE, OHIO

BEACH EROSION CONTROL

AND

FLOOD DAMAGE PREVENTION STUDY

U. S. Army Engineer District, Buffalo
1776 Niagara Street
Buffalo, New York 14207

EXHIBIT G2

I - INTRODUCTION

Shore erosion and flooding are major water resource problems on the Great Lakes. Millions of dollars in property loss and damage from erosion and flooding have been suffered by both public shoreline facilities and private shoreline property interests.

The principal causes of shore erosion and flooding problems in the Great Lakes area are the forces of nature and the characteristics of the shoreline area subjected to these forces.

The study area of the western Lake Erie shore (Ohio) consists of about seventy (70) miles of shoreline within the counties of Lucas and Ottawa, Ohio, whose shoreline characteristics range from low relief sand slopes to rocky bluffs of fifty (50) feet in height.

Predominant factors affecting the study area are the levels of Lake Erie and winds. In the past, the western Lake Erie shore has experienced high water levels which when combined with strong north to northeasterly winds cause serious beach and bluff erosion and flooding of low-lying areas along the shoreline.

In an effort to remedy these problems and facilitate a viable, economical, and environmental plan, all Ohio communities from the Ohio-Michigan State line to Marblehead, Ohio, will be studied. The project recommendations will be dependent on the seriousness of the continuing damage and the individual community's willingness to participate in Federal programs the Corps of Engineers is authorized to extend.

It is expected that the investigations made and the conclusions will give the Corps of Engineers an excellent base for proceeding with project implementation in carrying out the directives of the Congressional resolution authorizing the Western Lake Erie Shore Study.

II - STUDY AUTHORIZATION

Attached is a copy of the Committee on Public Works resolution authorizing this study as requested by the Honorable Delbert L. Latta of the 5th Congressional District of Ohio. The Corps prepared the referenced "Lake Erie Shore Line from the Michigan-Ohio State Line to Marblehead, Ohio" report in 1961.

U.S. HOUSE OF REPRESENTATIVES
WASHINGTON, D.C. 20515

RESOLUTION

Resolved by the Committee on Public Works of the House of Representatives, United States, that the Board of Engineers for Rivers and Harbors is hereby requested to review the report, Lake Erie Shore Line from the Michigan-Ohio State Line to Marblehead, Ohio, published as House Document Number 63, 87th Congress, 1st Session, and other pertinent reports, with a view to determining the advisability of providing for beach erosion control, flood protection and related purposes in the study area, with particular reference to the advisability of protection work against storm waves and wind generated high lake levels.

Adopted April 11, 1974

Attest: John A. Blatnik

John A. Blatnik, M.C.
Chairman

Requested by: Hon. Delbert L. Latta

III - EXISTING FLOOD CONTROL AND BEACH EROSION PROJECTS WITHIN THE STUDY AREA

OPERATION FORSIGHT PROJECTS

Point Place, Toledo

This project comprised of 19,950 feet of protective structures. A combination of earth dikes, riprap, faced earth dikes, sand-filled cribs and rock-filled cribs were placed along the shore of Maumee Bay. Sand-filled cribs in combination with gate closures and other structures, to elevation 579 feet, were placed along the river and at inland locations not subject to wave action. Additional Self-Help work using about $9,000 in Government-furnished material, was performed to complete the protection. All construction was completed by 30 November 1973.

Reno Beach-Howard Farms

Construction consisted of raising existing dikes and building new stone, and earth dikes along canals and within the area. Total length of the construction was 45,650 feet. Protection on the lakefront extended to elevation 582 feet, while dikes along interior canals and not exposed to wave action, were built to elevation 579 feet. The work was completed by 30 May 1973.

Bay Township

The project consisted of raising an existing dike, improving drainage facilities, and placement of a flap-gated drain through the dike. Pumps for interior drainage were provided by the Corps. Protection for 30 homes and 700 acres of farmland were provided and the work was completed by the end of September 1973.

EMERGENCY BANK PROTECTION (SECTION 14) PROJECTS

Sand Road, Catawba Island, Ohio

Extensive erosion area was present along a 1,000-foot length of shoreline which endangered Sand Road along the western side of Catawba Island. Emergency protection works were provided consisting of stone placement along the erodible bluff to a height of 582 feet IGLD. The work was completed in May 1978.

Oregon, Ohio

Emergency protection works were provided for the Oregon pump station in Lucas County, Ohio. The protection works included an earth dike

with riprap facing which encompassed the pump station. Protection was provided to elevation 582 feet IGLD. The project was completed in April 1978.

Kelley's Island, Ohio

Emergency protection works for an erodible bank were required at four areas along the southwestern section of shoreline. The planning and design which was made by NCE was subsequently changed by NCB. The protection works included stone ranging to three-ton capacity placed on a 1 vertical to 2 horizontal slope. The project was completed in October 1978 at a cost of $186,000.

OTHER CORPS WORKS IN THE WESTERN LAKE ERIE SHORE AREA

Reno Beach-Howard Farms Area..Emergency Repairs

The purpose for the emergency repairs was to assist local interests in fighting floods, and the restoration of flood control work threatened or destroyed by floods. Under Public Law 99, 84th Congress, restoration of existing dikes damaged by the Lake Erie storm of April 1966 was completed at a cost of $42,000. Subsequently, additional funds in the amount of $266,000 were provided for restoration in 1973, following the November 1972 Lake Erie storm.

LaCarne-Camp Perry..Local Flood Protection Project

This project is comprised of 3,250 feet of levee along Lake Erie, raising 880 feet of existing concrete wall along the lake, and a 3,650-foot tieback dike. The project was constructed in 1954 to prevent flooding and beach erosion.

OTHER CORPS WORKS IN THE WESTERN LAKE ERIE SHORE AREA

Toledo Harbor

Most work by the Corps of Engineers at the Toledo Harbor consists of channel deepening and widening in an effort to take advantage of the larger, deeper draft lake carriers and ocean-going vessels. To date the Federal costs for improvement of Toledo Harbor amount to about $17,200,000. About $25,200,000 has been spent to date in maintaining authorized channel depths and widths. In addition approximately $18,200,000 has been spent on dike disposal facilities.

Put-in-Bay Harbor

In 1939, the Corps of Engineers dredged the harbor front area which contributed to the development of the resort area. Also included in

the project was a 14-foot deep flared approach channel to the ferry docks.

West Harbor Small-Boat Harbor

The 1965 River and Harbor Act authorized Federal improvements by construction of a breakwater protected entrance from Lake Erie into the natural outlet of West Harbor, with access channels leading to the berthing areas. Final design of this small-boat harbor project is underway and construction is scheduled to start in Fiscal Year 1980.

East Harbor Small-Boat Harbor

A Detailed Project Report under authority of Section 107 of the 1960 River and Harbor Act, has been initiated for improvement of East Harbor in the interest of recreational navigation. The work would consist of an extension of the existing west breakwater, a new detached breakwater, an improved entrance channel between the breakwaters, and an access channel and anchorage area within the harbor lagoon. Subsequent to the beginning of preconstruction planning, local interests requested that alternate sites be considered for location of the harbor. An investigation of the alternative sites is dependent on the State of Ohio finalizing its master plan for the Lake Erie Islands and the availability of funds.

Kelleys Island Harbor

Kelleys Island Harbor was studied under authority of Section 107 of the 1960 River and Harbor Act in 1968. The project would provide for two breakwaters having an aggregate length of about 1,100 feet, with recreational fishing facilities provided thereon; a flared approach 12 feet deep, decreasing in width to 100 feet between the breakwaters; an entrance channel 10 feet deep and varying in width from 300 feet at a point about 200 feet offshore to 150 feet at the shoreline; and an access and maneuvering of about 4.3 acres, 8 to 10 feet deep. Subsequent to the beginning of preconstruction planning, local interests requested that alternate sites be considered for location of the harbor. An investigation of the alternative sites is dependent on the State of Ohio finalizing its master plan for the Lake Erie islands and the availability of funds.

Crane Creek State Park Shore Protection Project

This active authorized project which was authorized by the Flood Control Act of 1962, would include restoration and protection of the shore by construction of a sand barrier beach along 17,800 feet of shore. Thirty-six groins spaced generally at 500-foot intervals and

extending about 300 feet lakeward would be constructed to trap littoral drift and reduce future erosion. To presen.., no planning or construction funds have been allotted.

Point Place Local Flood Protection Project

The project would consist of a system of rubblemound lakefront dikes and riprap-faced earth levees along Ottawa River, forming a protective network around the floodprone areas of the subdivision. The improvements would prevent damage from Lake Erie storms resulting from the maximum possible wave runup that can be produced by severe easterly winds occurring in conjunction with a high lake stage of twenty year frequency or less. Preconstruction planning is underway and construction is scheduled to start in FY 79.

Reno Beach-Howard Farms Area Local Flood Protection Project

This active authorized project which was authorized by the River and Harbor Act of 1948, would protect the area from flood damages resulting from windstorms and high stages of water on Lake Erie, enhance land values, add materially to recreational facilities, and increase the security of the residents. At present, no planning or construction funds have been allotted.

Great Lakes Basin Framework Study

This basin planning study, completed in 1976, included eight basin States and eleven Federal agencies active in water resource development. Responsibility for sections of the overall water and land resource study was assigned on a functional basis and the findings of the study suggest methods, alternatives, and policies to meet the region's water and related land resources to the year 2020.

Reno Beach, Lucas County Study

The purpose of the Reno Beach, Lucas County Study is to determine the advisability of providing flood protection, with particular reference to protection against storm waves and wind which generated temporary high lake levels. The Reno Beach, Lucas County, Ohio Study was published in House Document 554, 80th Congress, 2nd Session.

Water Levels of the Great Lakes Study

A study of the fluctuations of the water levels of the Great Lakes had its origin in 1952 in a resolution of the Committee on Public Works of the House of Representatives. In 1964 the International Great Lakes Levels Board was established by the International Joint Commission (IJC). The Levels Board completed its report in 1973, and

the IJC made its report to the Governments of Canada and the United States in 1976. The Corps of Engineers had the prime responsibility among U. S. agencies for the work on the water levels investigation.

In summary, the completed and proposed Corps projects are for the most part individual problems at certain locations and developed in some cases for a single purpose need.

In addition to the Corps of Engineers projects located within the study area, the Ohio Department of Natural Resources has been involved in implementing the Ohio Coastal Zone Management Program along the entire Ohio shoreline. This program has been addressing numerous problems along Lake Erie, including flooding and erosion, fish and wildlife habitat destruction, port and harbor development, water quality, access to the lake, and inconsistent, unwise use of the lake shore. Buffalo District desires to prevent duplication of study effort and programs by others. Thus, every effort will be made to coordinate the Western Lake Erie Shore Study with other agencies at the Federal, State, regional, county and local levels involved in planning and construction of water resources projects on Lake Erie. Your input regarding on-going activities by others is vital to this goal.

IV - THE STUDY PROCESS

This Corps of Engineers study is referred to as a "Feasibility Study" with plans being developed in three (3) stages, as shown in Figure 1.

The initial stage, Stage I, is a "Reconnaissance Study." The intermediate stage, Stage II, defines a broad range of alternative plans to be developed and analyzed; and the final stage, Stage III, involves screening these plans and developing detailed plans as a basis for selection and recommendation.

The reconnaissance study document represents the completion of the Stage I study process which sets forth the study scope with primary emphasis on problem identification. This document will determine what the overall study will involve. Local input is necessary for problem identification and possible solutions. The reconnaissance study will include the purposes of the study, the systematic program for managing the overall study effort, allocations of the necessary effort, skills, participants, and cost of conducting the study, results of Stage I study efforts, and the anticipated coordination and public involvement program. When the Stage II portion of the study process is initiated and completed, a range of alternative ways of accomplishing the planning objectives is developed. The major trust during the Stage II study process is the development of economically justified and environmentally acceptable alternatives with either structural or nonstructural solutions. These plans and the accompanying work accomplished at the time will be presented in the Preliminary Feasibility Report (PFR).

Stage III refines and reduces the range of alternatives leading to the selection of the plan that will best accomplish the planning objectives, including the emphasis on assessment and evaluation. The recommendation of any of the alternatives is based on the overall Federal interest. The plans, accounts and recommendations will be presented in the Final Feasibility Report (FFR).

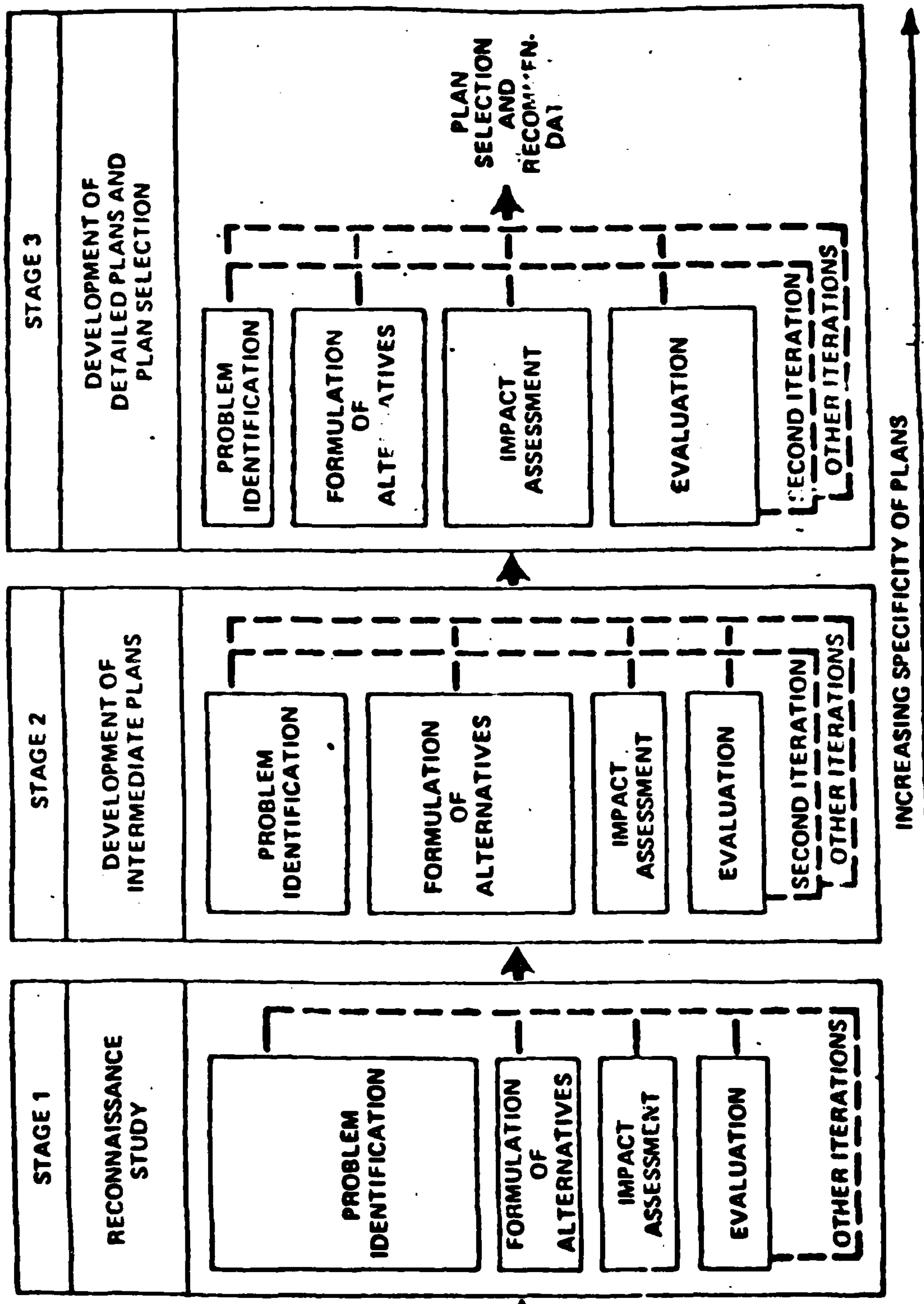


FIGURE 1: GENERAL RELATIONSHIP OF PLAN DEVELOPMENT STAGES AND FUNCTIONAL PLANNING TASKS

V - LIMITS OF FEDERAL PARTICIPATION

The extent of Federal participation toward beach erosion projects varies from 100 percent to none, dependent upon the shore ownership, use, and type and incidence of benefits. Figure 2 summarizes the extent of Federal participation in beach erosion control projects for the five categories of beach ownership.

Projects providing Hurricane, Tidal, and Lake Flood Protection authorized in the 1958 Flood Control Act established a precedent of limiting the Federal share of project cost to a maximum of 70 percent. It has been Corps practice to include similar cost sharing for all subsequent justified hurricane protection projects recommended for Congressional authorization. When the normal local costs of lands, easements, rights-of-way, and relocations amount to less than 30 percent of total first costs, the difference is required as a local cash contribution; when those local costs exceed 30 percent, they become the minimum requirement. Successful protection against hurricane and tidal flooding on the open coast frequently requires that the shoreline be concomitantly stabilized against erosion. For multiple-purpose hurricane protection and beach erosion control projects, Section 208 of the 1970 Flood Control Act provides discretionary power to the Secretary of the Army acting through the Chief of Engineers to authorize a Federal share up to 70 percent of the project costs exclusive of land costs. Cases warranting such adjustments are to be submitted to the Chief of Engineers for consideration.

Limits of Federal Participation
Towards Beach Erosion Control Projects

Shore Category	Maximum Level of Federal Aid: Construction %	Maximum Level of Federal Aid: Maintenance %
I Federally owned	100	100
II Publicly owned, non-Federal parks and conservation areas	70 (1)(2)	None
III Publicly owned, non-Federal other than parks and conservation areas	50	None
IV Privately owned, protection will result in public benefits (3)	50 (1)(2) multiplied by the ratio of public benefits along Cat. IV shore to total benefits along Cat. IV shore	None
V Privately owned, protection will not result in public benefits susceptible of evaluation	None	None

(1) Cost-sharing percentages do not include lands, easements, and rights-of-way, which are entirely a non-Federal cost.

(2) Federal aid may be provided for beach nourishment. (Generally, a time limit of 10 years has been placed on Federal participation. However, the current trend is to recommend Federal participation for the life of the project.)

(3) Privately-owned shores under public control, as through a sufficiently long-term lease assuring realization of public benefits throughout the economic life of the project, may be treated as Category III shores in determining Federal aid.

VI - PURPOSE OF WORKSHOP MEETINGS

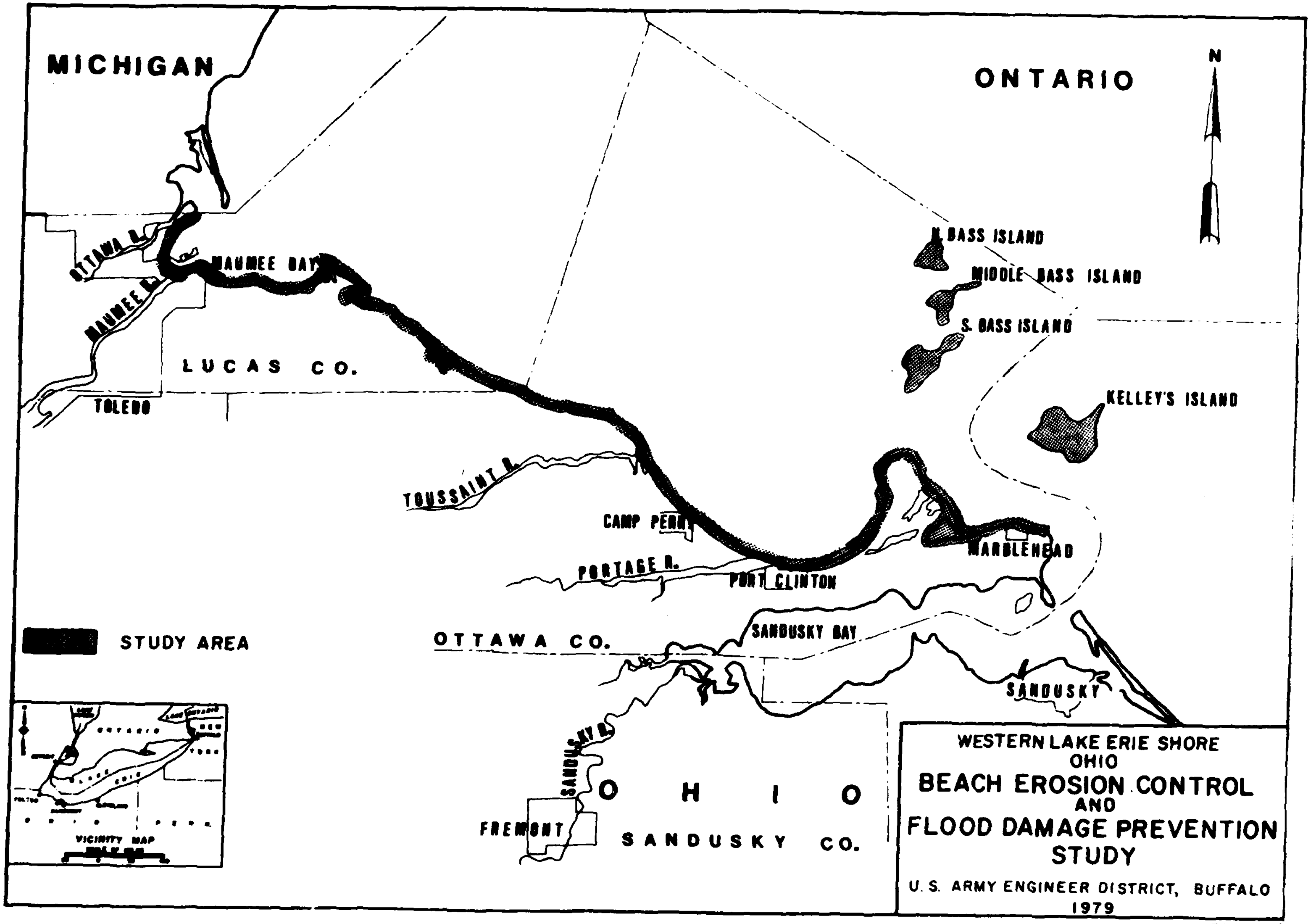
Workshop meetings provide an opportunity for us to meet with you, the interested public, and to openly and informally discuss your problems, needs, desires, and goals for the shoreline. These meetings provide an opportunity for us to communicate with you and simplify the future exchange of information, ideas, and suggestions during the developmemt and assessment of planning alternatives. We need this input from you to insure that the study considers all views and reflects public sentiment.

The workshops also provide you the opportunity to obtain information on the Corps study effort. We hope to answer your questions on our study priorities, the areas of major shoreline erosion and inundation, available data on the study schedule, the regulations - both agency and legislative - under which we operate, and the economic, environmental, etc., criteria we must meet. Workshops permit us to identify the various interest groups in the study area, obtain their viewpoints on priorities and ranking of problems.

The workshops also provide input to both the Corps and the public that is beneficial in preparing for public meetings. The goal in all phases of the study process is to develop a product that best serves the needs of the total community of the study area. We think the workshop will help us reach this goal.

Although these meetings are open to all, we feel that they are most successful and productive when limited in size to about 15 to 20 active participants. Thus, our selectivity in limiting the number of invitations to this workshop.

We would like to begin the workshop by introducing all participants. We then plan to review portions of this hand-out, then begin discussing on-going studies, data and facts regarding what we know and don't know about the problem areas within the study area. We hope that you will actively participate in the discussion and the two-way question and answer session to follow. We will conclude the meeting by a review and summary of key discussion points.



MICHIGAN
ONTARIO
N
N. BASS ISLAND
MIDDLE BASS ISLAND
S. BASS ISLAND
KELLEY'S ISLAND
OTTAWA R.
MAUMEE R.
MAUMEE BAY
LUCAS CO.
TOLEDO
TOUSSAINT R.
CAMP PERRY
PORTAGE R.
PORT CLINTON
MARBLEHEAD
SANDUSKY BAY
SANDUSKY
OTTAWA CO.
STUDY AREA
SANDUSKY R.
FREMONT
OHIO
SANDUSKY CO.
VICINITY MAP
WESTERN LAKE ERIE SHORE
OHIO
BEACH EROSION CONTROL
AND
FLOOD DAMAGE PREVENTION
STUDY
U.S. ARMY ENGINEER DISTRICT, BUFFALO
1979

PLATE I

WESTERN LAKE ERIE SHORE, OHIO
BEACH EROSION CONTROL
AND
FLOOD DAMAGE PREVENTION STUDY

FIRST
AREA WORKSHOP MEETING

1:00 P.M.
10 JANUARY 1979
AT
JERUSALEM TOWNSHIP HALL
ROUTE 2
CURTICE, OHIO 43412

U. S. Army Engineers District, Buffalo
1776 Niagara Street
Buffalo, NY 14207

ORIENTATION MEETING
FOR
WESTERN LAKE ERIE SHORE, OHIO STUDY
Wednesday, 10 January 1979 (1:00 p.m.)

I. Welcome and opening remarks

A. 1:00 p.m. - 1:15 p.m. Introduction by Corps and participants

II. Discussion of Western Lake Erie Shore, Ohio - Corps

A. 1:15 p.m. - 1:45 p.m.

1. Discuss authorization
2. Progress to date
3. Proposed program and study schedule
4. Description of study area

III. Views of local and State agencies - Group Discussion

A. 1:45 p.m. - 3:15 p.m.

1. Discuss beach and bluff erosion areas
2. Discuss areas experiencing flood inundation
3. Discuss other water resources problems and needs along Lake Erie in study area

IV. Discussion of Maumee Bay State Park - Ohio Department of Natural Resources

A. 3:15 p.m. - 3:30 p.m.

1. State of Ohio's proposed program
2. Corps of Engineers involvement

V. General Discussion - Group Discussion

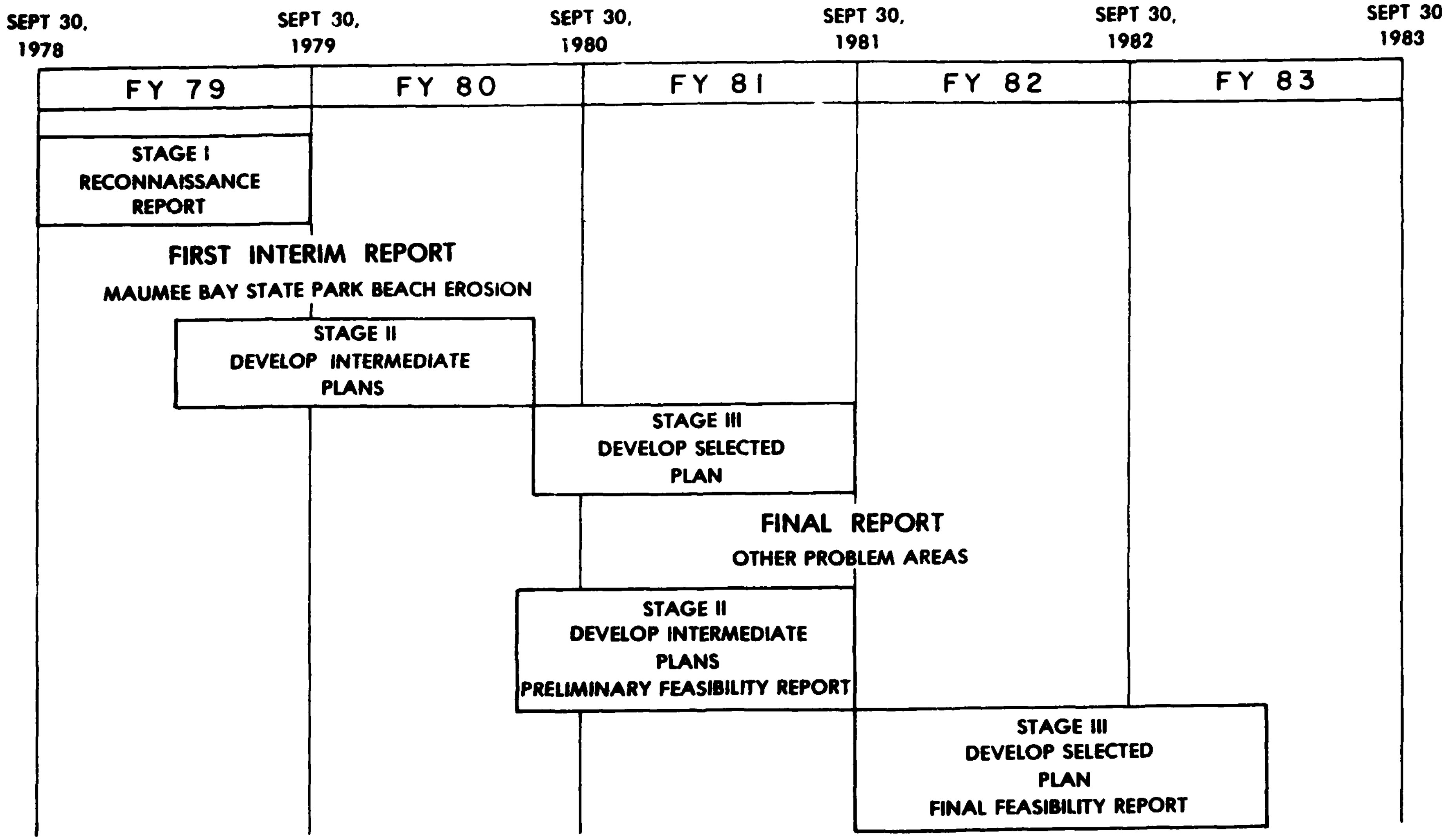
A. 3:30 p.m. - 3:45 p.m.

VI. Summary and Closing Remarks - Corps

A. 3:45 p.m. - 4:00 p.m.

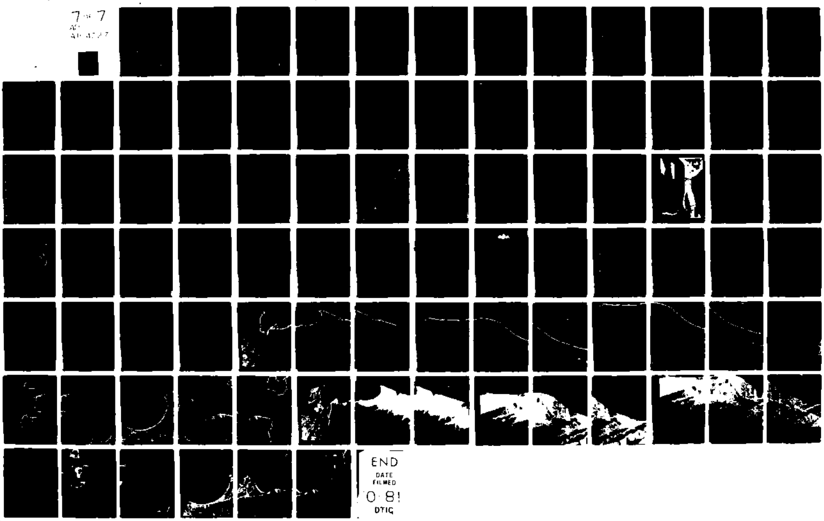
PROPOSED SCHEDULE OF MAJOR ACTIVITIES FOR WESTERN LAKE ERIE SHORE, OHIO

BEACH EROSION CONTROL AND FLOOD DAMAGE PREVENTION STUDY

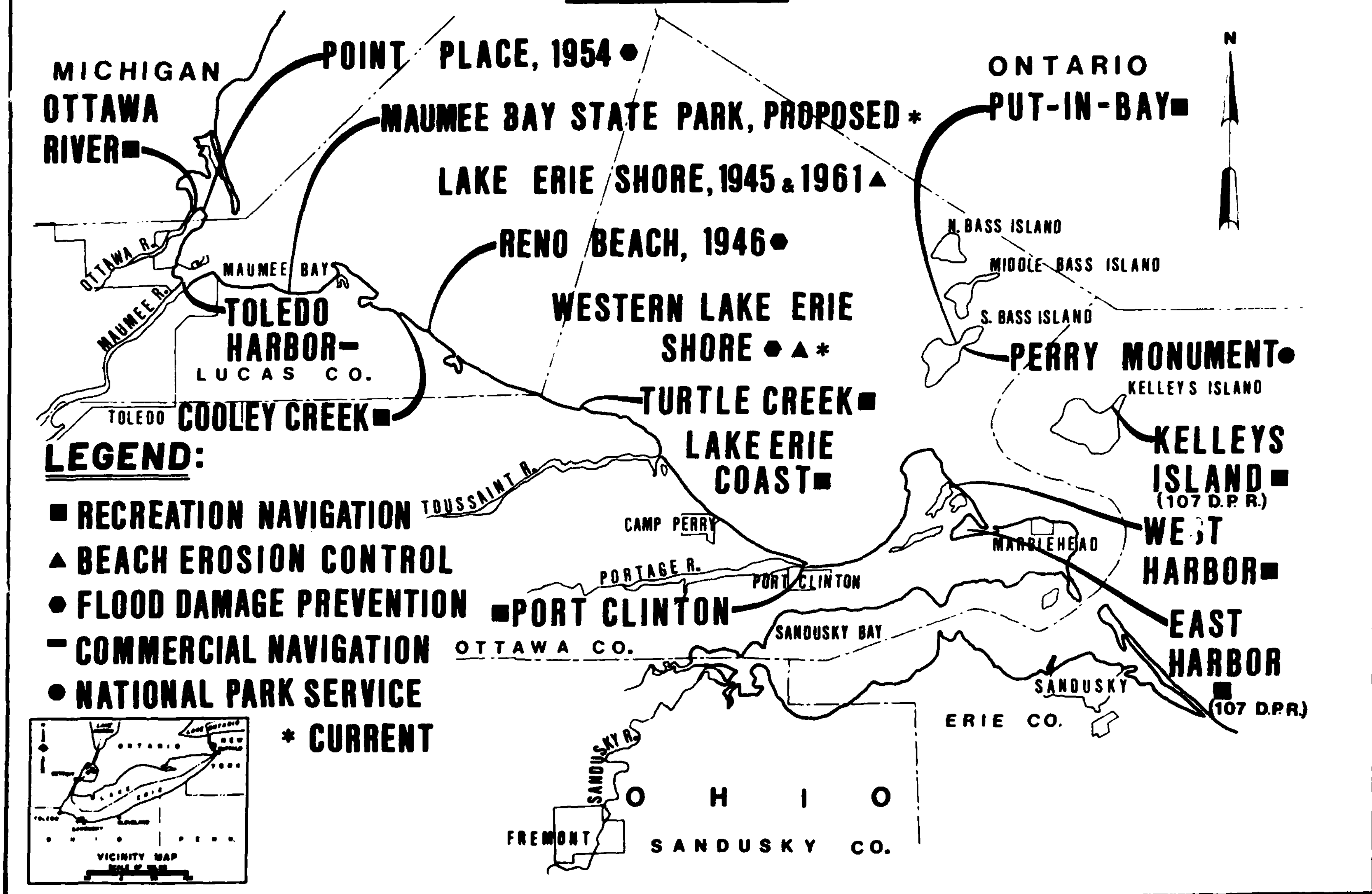


AD-A104 227 CORPS OF ENGINEERS BUFFALO NY BUFFALO DISTRICT F/G 13/2
WESTERN LAKE ERIE SHORE STUDY, OHIO. RECONNAISSANCE REPORT (STA--ETC(U)
JUN 81 J ZORICH

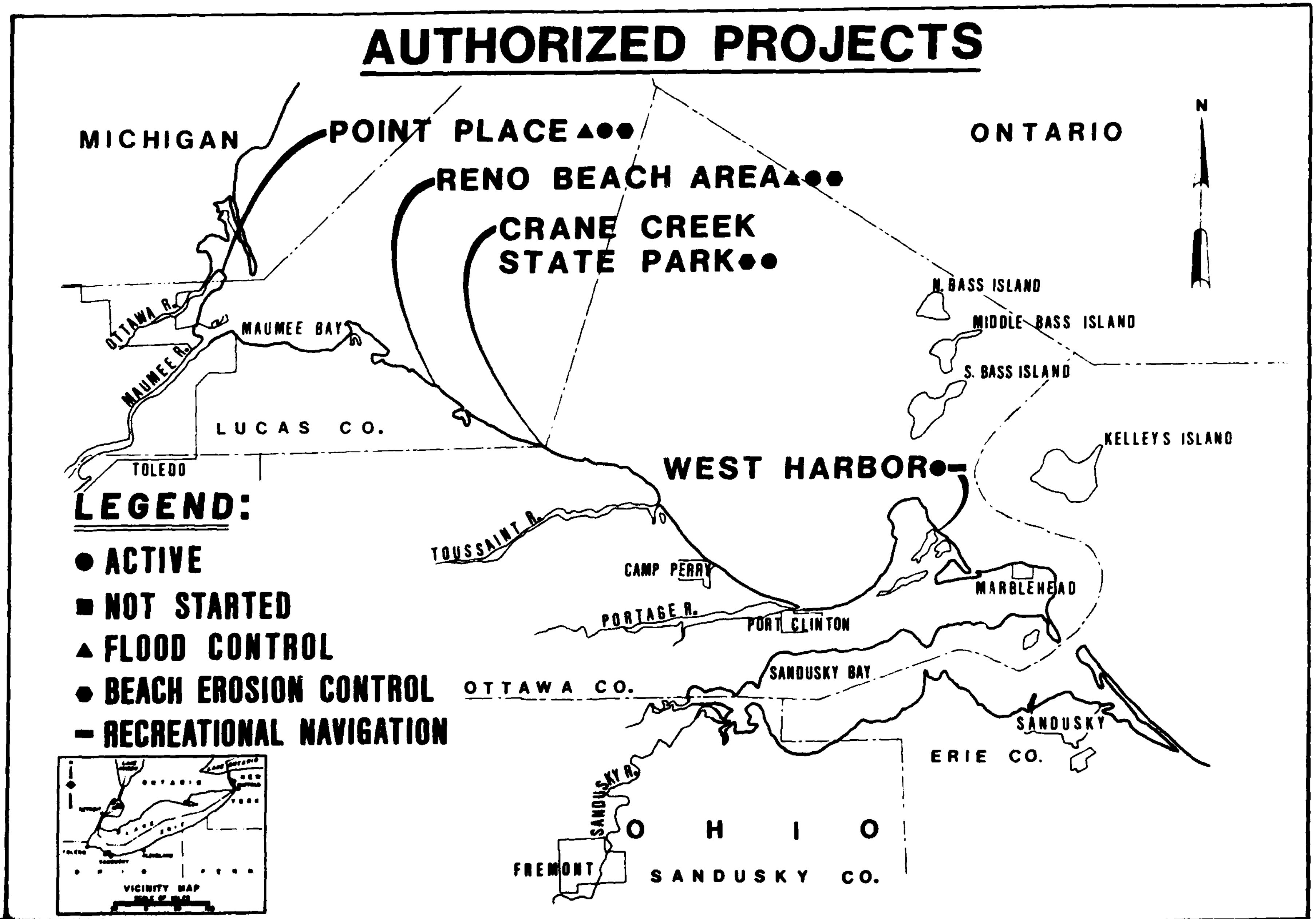
UNCLASSIFIED NL

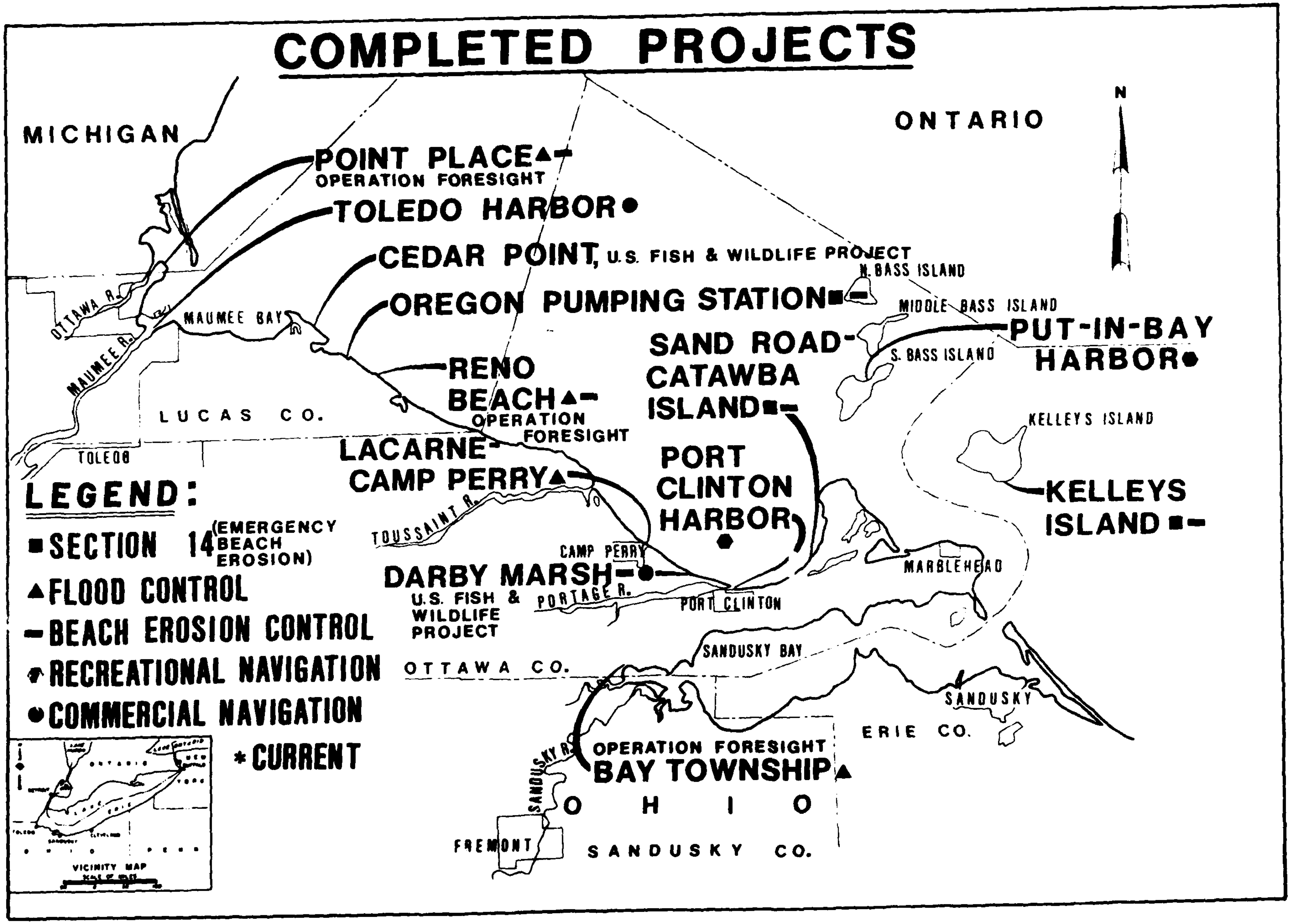


STUDIES



MICHIGAN
OTTAWA RIVER ■
POINT PLACE, 1954 ⬢
MAUMEE BAY STATE PARK, PROPOSED *
LAKE ERIE SHORE, 1945 & 1961 ▲
RENO BEACH, 1946 ⬢
WESTERN LAKE ERIE SHORE ⬢ ▲ *
TURTLE CREEK ■
LAKE ERIE COAST ■
ONTARIO
PUT-IN-BAY ■
N
N. BASS ISLAND
MIDDLE BASS ISLAND
S. BASS ISLAND
PERRY MONUMENT ●
KELLEYS ISLAND
KELLEYS ISLAND ■ (107 D.P.R.)
WEST HARBOR ■
EAST HARBOR ■ (107 D.P.R.)
MARBLEHEAD
OTTAWA R.
MAUMEE R.
MAUMEE BAY
TOLEDO HARBOR —
LUCAS CO.
TOLEDO
COOLEY CREEK ■
TOUSSAINT R.
CAMP PERRY
PORTAGE R.
PORT CLINTON
■ PORT CLINTON
SANDUSKY BAY
OTTAWA CO.
SANDUSKY
ERIE CO.
SANDUSKY R.
OHIO
FREMONT
SANDUSKY CO.
LEGEND:
■ RECREATION NAVIGATION
▲ BEACH EROSION CONTROL
⬢ FLOOD DAMAGE PREVENTION
— COMMERCIAL NAVIGATION
● NATIONAL PARK SERVICE
* CURRENT
VICINITY MAP


AUTHORIZED PROJECTS
MICHIGAN
ONTARIO
N
POINT PLACE ▲●●
RENO BEACH AREA▲●●
CRANE CREEK
STATE PARK●●
N. BASS ISLAND
MIDDLE BASS ISLAND
S. BASS ISLAND
KELLEYS ISLAND
WEST HARBOR●▬
OTTAWA R.
MAUMEE R.
MAUMEE BAY
LUCAS CO.
TOLEDO
TOUSSAINT R.
CAMP PERRY
PORTAGE R.
PORT CLINTON
MARBLEHEAD
SANDUSKY BAY
OTTAWA CO.
SANDUSKY
ERIE CO.
SANDUSKY R.
OHIO
FREMONT
SANDUSKY CO.
LEGEND:
● ACTIVE
■ NOT STARTED
▲ FLOOD CONTROL
⬢ BEACH EROSION CONTROL
▬ RECREATIONAL NAVIGATION
VICINITY MAP



COMPLETED PROJECTS
MICHIGAN
ONTARIO
N
POINT PLACE
OPERATION FORESIGHT
TOLEDO HARBOR
CEDAR POINT, U.S. FISH & WILDLIFE PROJECT
OREGON PUMPING STATION
N. BASS ISLAND
MIDDLE BASS ISLAND
S. BASS ISLAND
PUT-IN-BAY HARBOR
SAND ROAD
CATAWBA ISLAND
RENO BEACH
OPERATION FORESIGHT
LACARNE
CAMP PERRY
PORT CLINTON HARBOR
KELLEYS ISLAND
KELLEYS ISLAND
OTTAWA R.
MAUMEE R.
MAUMEE BAY
LUCAS CO.
TOLEDO
TOUSSAINT R.
CAMP PERRY
DARBY MARSH
U.S. FISH & WILDLIFE PROJECT
PORTAGE R.
PORT CLINTON
MARBLEHEAD
SANDUSKY BAY
OTTAWA CO.
SANDUSKY
ERIE CO.
OPERATION FORESIGHT
BAY TOWNSHIP
SANDUSKY R.
OHIO
FREMONT
SANDUSKY CO.
LEGEND:
SECTION 14 (EMERGENCY BEACH EROSION)
FLOOD CONTROL
BEACH EROSION CONTROL
RECREATIONAL NAVIGATION
COMMERCIAL NAVIGATION
* CURRENT
VICINITY MAP

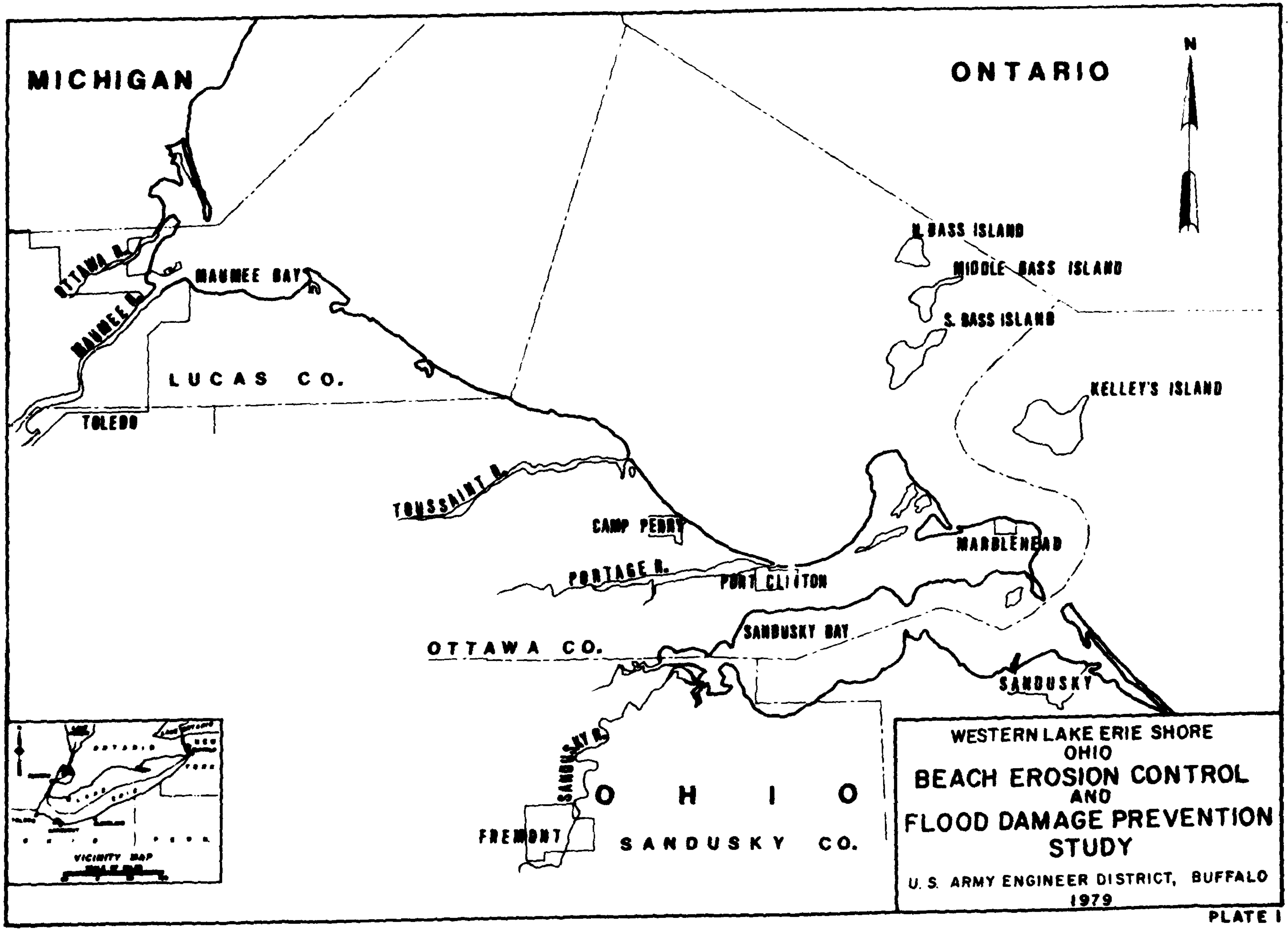

MICHIGAN
ONTARIO
N
N. BASS ISLAND
MIDDLE BASS ISLAND
S. BASS ISLAND
KELLEY'S ISLAND
OTTAWA R.
MAUMEE R.
MAUMEE BAY
LUCAS CO.
TOLEDO
TOUSSAINT R.
CAMP PERRY
PORTAGE R.
PORT CLINTON
MARBLEHEAD
SANDUSKY BAY
OTTAWA CO.
SANDUSKY
SANDUSKY R.
FREMONT
OHIO
SANDUSKY CO.
VICINITY MAP
WESTERN LAKE ERIE SHORE
OHIO
BEACH EROSION CONTROL
AND
FLOOD DAMAGE PREVENTION
STUDY
U. S. ARMY ENGINEER DISTRICT, BUFFALO
1979

PLATE I

WESTERN LAKE ERIE SHORE, OHIO
BEACH EROSION CONTROL
AND
FLOOD DAMAGE PREVENTION STUDY

FIRST
AREA WORKSHOP MEETING

1:00 P.M.
11 JANUARY 1979
AT
OAK HARBOR COUNCIL CHAMBERS
146 CHURCH STREET
OAK HARBOR, OHIO 43449

U. S. Army Engineers District, Buffalo
1776 Niagara Street
Buffalo, NY 14207

ORIENTATION MEETING
FOR
WESTERN LAKE ERIE SHORE, OHIO STUDY
Thursday, 11 January 1979 (1:00 p.m.)

I. Welcome and opening remarks

A. 1:00 p.m. - 1:15 p.m. Introduction by Corps and participants

II. Discussion of Western Lake Erie Shore, Ohio - Corps

A. 1:15 p.m. - 1:45 p.m.

1. Discuss authorization
2. Progress to date
3. Proposed program and study schedule
4. Description of study area

III. Views of local and State agencies - Group Discussion

A. 1:45 p.m. - 3:30 p.m.

1. Discuss beach and bluff erosion areas
2. Discuss areas experiencing flood inundation
3. Discuss other water resources problems and needs along Lake Erie in study area.

IV. General Discussion - Group Discussion

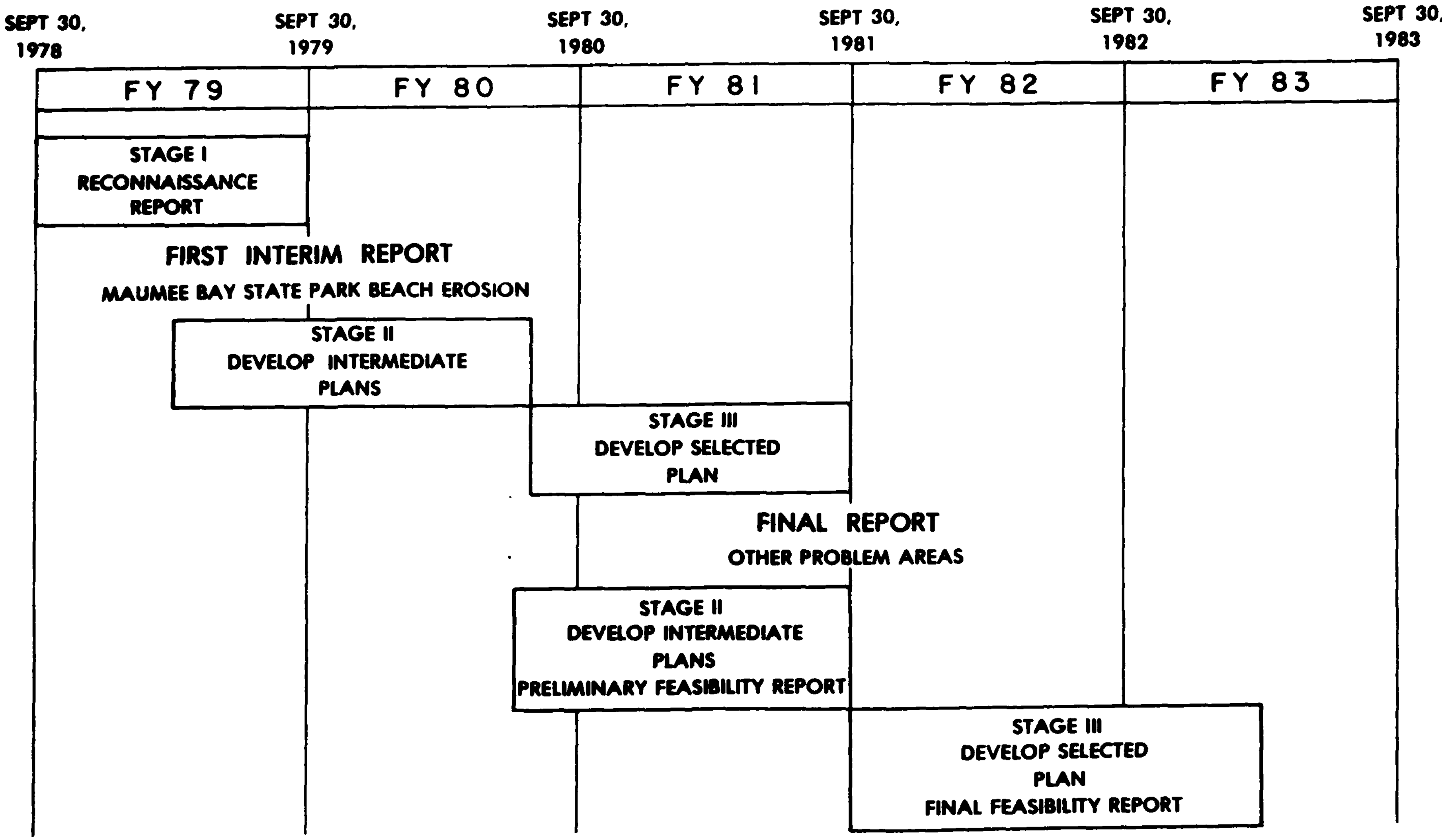
A. 3:30 p.m. - 3:45 p.m.

V. Summary and Closing Remarks - Corps

A. 3:45 p.m. - 4:00 p.m.

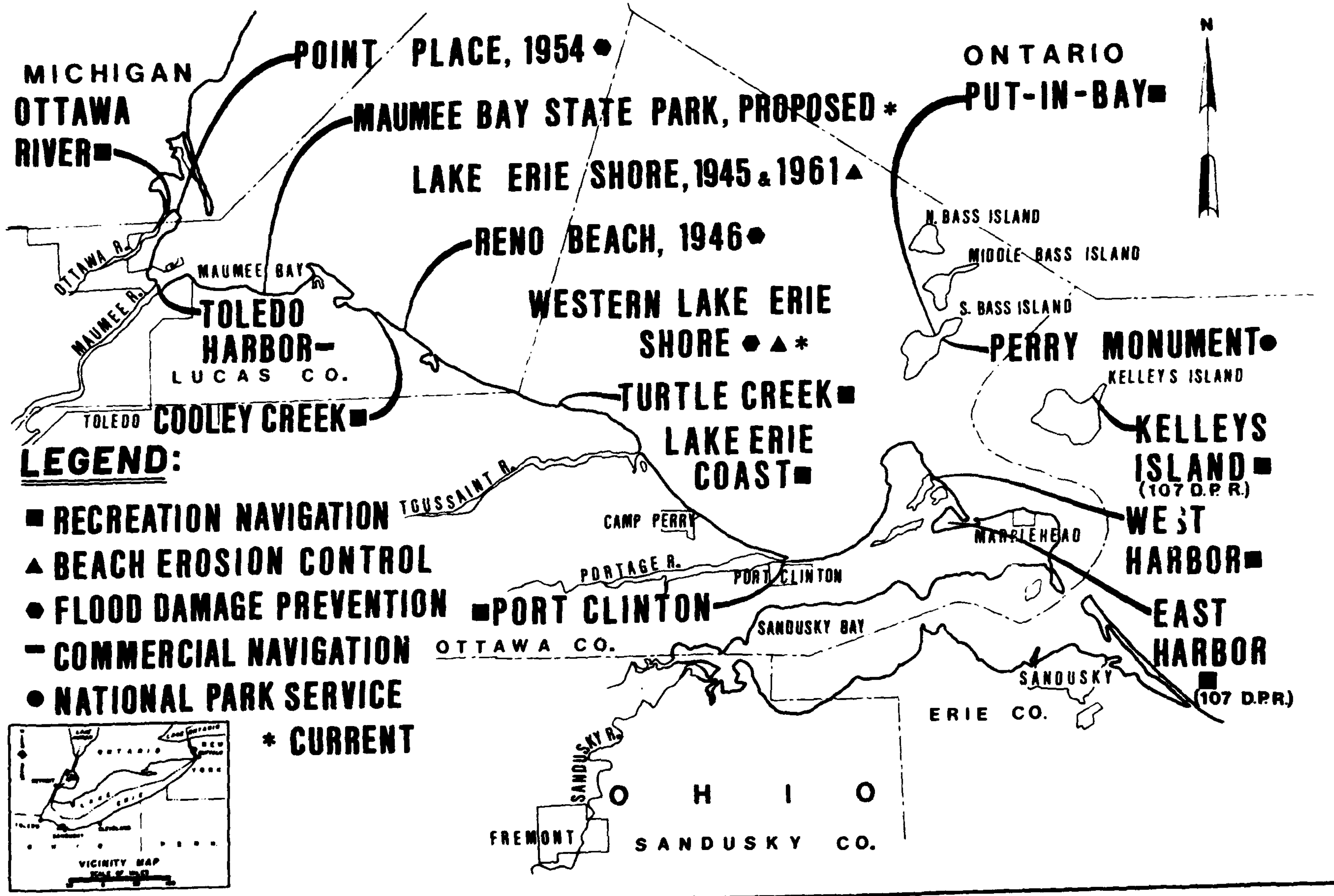
PROPOSED SCHEDULE OF MAJOR ACTIVITIES FOR WESTERN LAKE ERIE SHORE, OHIO

BEACH EROSION CONTROL AND FLOOD DAMAGE PREVENTION STUDY



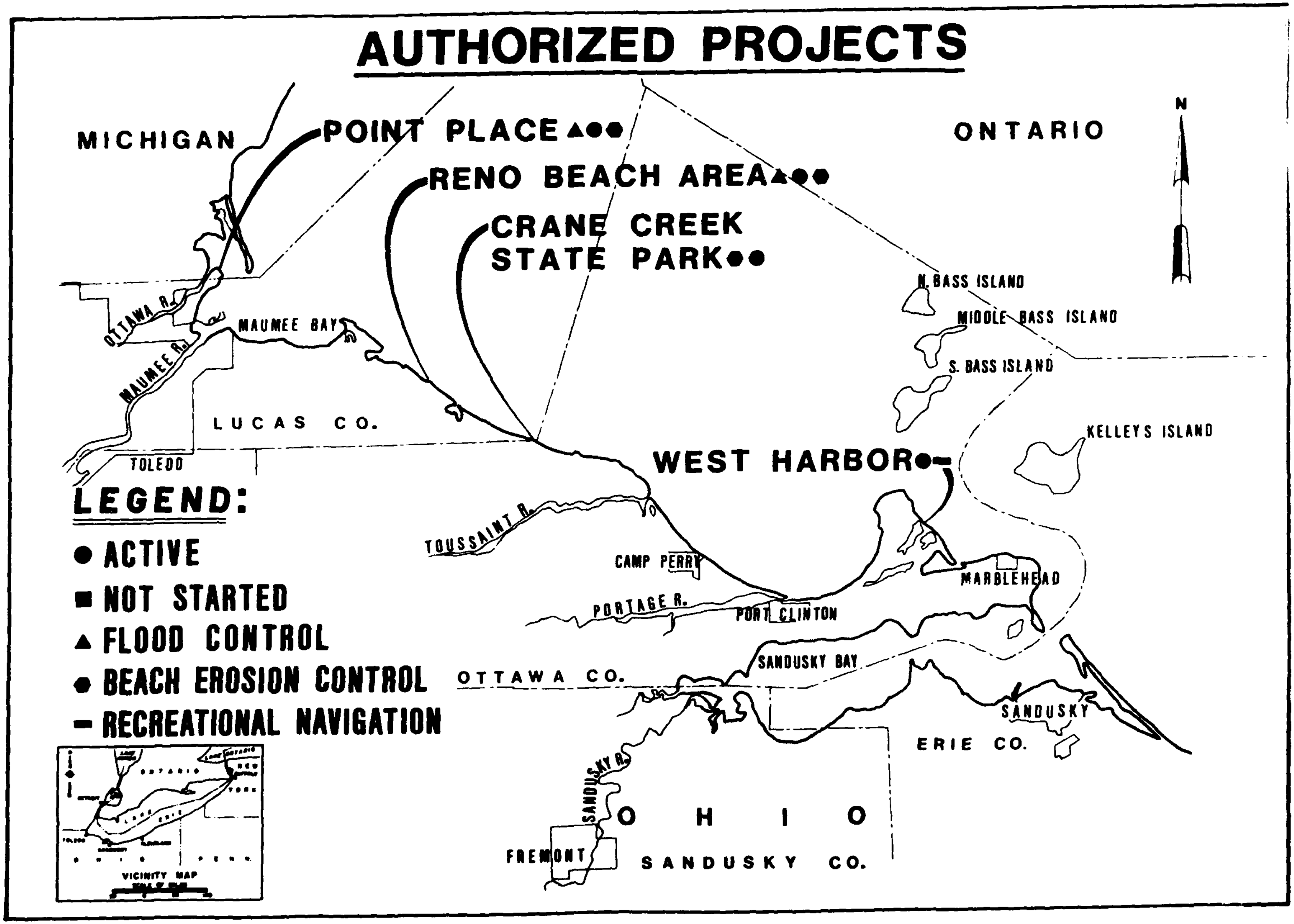
8 January 1979

STUDIES



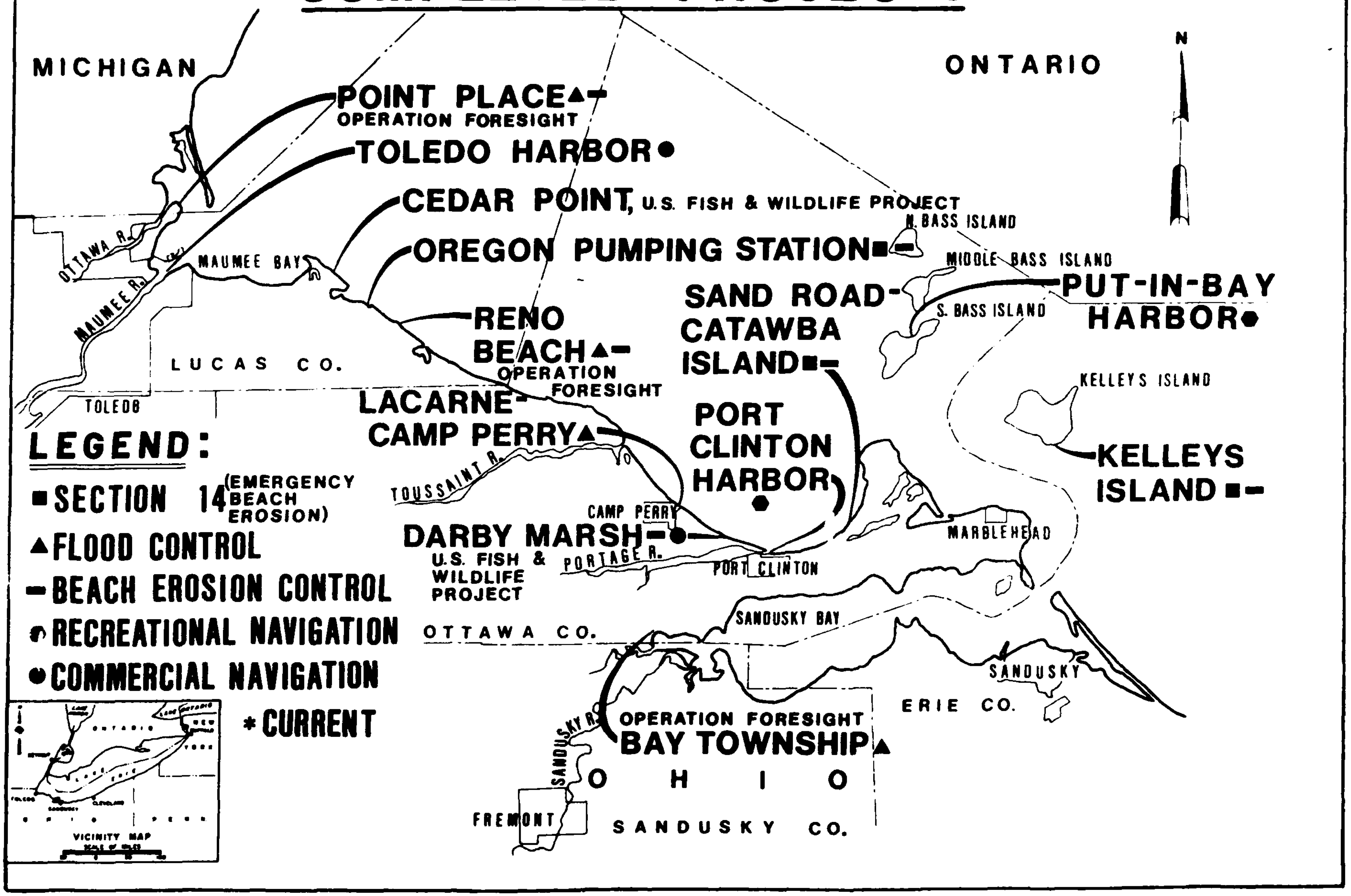
LEGEND:

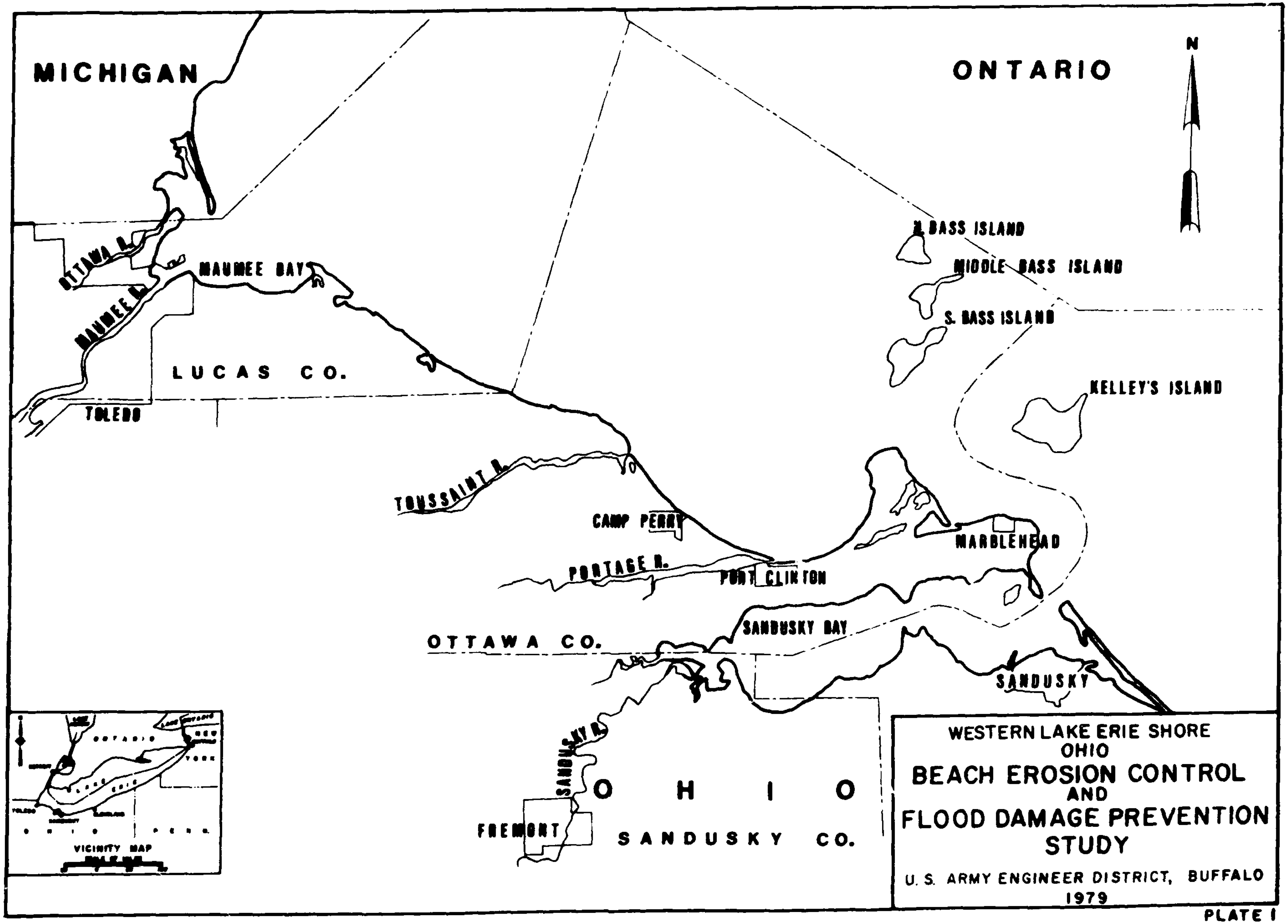
- ■ RECREATION NAVIGATION
- ▲ BEACH EROSION CONTROL
- ⬢ FLOOD DAMAGE PREVENTION
- – COMMERCIAL NAVIGATION
- ● NATIONAL PARK SERVICE
- * CURRENT



AUTHORIZED PROJECTS
POINT PLACE
RENO BEACH AREA
CRANE CREEK
STATE PARK
WEST HARBOR
MICHIGAN
ONTARIO
N
N. BASS ISLAND
MIDDLE BASS ISLAND
S. BASS ISLAND
KELLEYS ISLAND
OTTAWA R.
MAUMEE R.
MAUMEE BAY
LUCAS CO.
TOLEDO
TOUSSAINT R.
CAMP PERRY
PORTAGE R.
PORT CLINTON
MARBLEHEAD
SANDUSKY BAY
OTTAWA CO.
SANDUSKY
ERIE CO.
SANDUSKY R.
OHIO
FREMONT
SANDUSKY CO.
LEGEND:
● ACTIVE
■ NOT STARTED
▲ FLOOD CONTROL
⬢ BEACH EROSION CONTROL
– RECREATIONAL NAVIGATION
VICINITY MAP

COMPLETED PROJECTS





WESTERN LAKE ERIE SHORE
OHIO
BEACH EROSION CONTROL
AND
FLOOD DAMAGE PREVENTION
STUDY

U. S. ARMY ENGINEER DISTRICT, BUFFALO
1979

PLATE I

SUMMARY MINUTES
FOR
ORIENTATION WORKSHOP
ON
WESTERN LAKE ERIE SHORE FEASIBILITY STUDY, OHIO
WEDNESDAY, 10 JANUARY 1979

1. An Orientation Workshop concerning the Western Lake Erie Shore, Ohio, Study, was held at 1 p.m. on 10 January 1979, at the Jerusalem Township Hall on Route 2, Curtice, Ohio. The purpose of this Workshop was to inform public officials and other principal interests in Lucas County of the Study and to solicit their views on water resources problems and needs in the study area. This input on problems and needs is instrumental in scoping the future study effort and will be incorporated into the Reconnaissance Report currently underway.

The study deals with the feasibility of providing for beach erosion control, flood protection, and related purposes in the study area.

2. John Zorich, Chief of the Western Basin, welcomed all present and opened the meeting with self-introduction. Discussion of the Western Lake Erie Shore Study was initiated with a review of the Committee Resolution requested by Honorable Delbert Latta on 11 April 1974. The proposed Corps of Engineers program and study schedule, including progress to date, was then presented and the Corps of Engineers study process was explained in more detail as outlined in an information package that was given to Workshop participants. A list of Workshop Attendees is provided at the end of these minutes.

3. Subsequently, Mr. Zorich discussed previous Corps of Engineers studies and completed projects located within the study area. Information was also provided as to current Corps of Engineers activities, namely current studies and authorized projects. Maps of the shoreline area between Ohio-Michigan line and Marblehead, Ohio, depicting this information was also provided Workshop participants as part of the information packet.

4. A brief slide presentation of the shoreline was made by the Project Manager, James H. DeLaPlante III. The purpose of the slide presentation was to acclimate the audience and the Corps Interdisciplinary Team for this study to the geographical and topographical characteristics of the shoreline within the study area especially the Lucas County shoreline and problem areas.

5. Mr. Charles Carter, Head of Lake Erie Section of the Division of Geological Survey of Ohio Department of Natural Resources (ODNR)

Incl 1

EXHIBIT G3

explained that a Lake Erie Shore Erosion and Flooding Report for Lucas County has been just completed, and is available. A similar report is presently being prepared by the Lake Erie Section compiled for Ottawa County, and will be available late in 1979.

6. Mr. Fred Ball of the Office of the Chief of Engineering, ODNR, presented an overview as to the State of Ohio's intentions for developing Maumee Bay State Park. Camp grounds development and construction is expected to begin this year. The State's position at present is to incorporate its recreational development plan in with potential flood control and erosion protection facilities and a recreational beach that the Corps of Engineers will investigate as part of the Western Lake Erie Shore study. Two major concerns about the Maumee State Park project were expressed by local officials during this discussion. First, Mr. Horvath of the city of Oregon is concerned that the proposed Maumee Bay Park project could adversely affect the existing drainage system and the area to be developed. Secondly, Mr. Wilson, Lucas County Engineer, is concerned that heavy construction vehicle traffic on existing area roadways could likely damage the roadways and require repairs and possibly replacement.

7. Mr. Thomas Schultz of the Toledo Metropolitan Area Council of Governments explained their involvement with the Toledo area and the data that is available to the Corps of Engineers.

8. Mr. Roger Van Hoose, president of Lake Erie Conservancy District Number One, explained the history of the conservancy district and clarified some points as to the Corps of Engineers involvement with both the Howard Farms Reno Beach Conservancy and Lake Erie Conservancy Number One regarding projects constructed in past years.

9. Some areas of potential problems were discussed with respect to erosion and flood inundation from high Lake Erie levels and wave runup. Some areas that were identified are:

a. Flooding problems in the village of Bono.

b. Severe flooding in Lucas County occurs from Little Cedar Point to Harbor View in the city of Oregon.

c. Potential flooding area along Crane Creek affecting upstream areas.

d. Flooding problems to inland agricultural lands due to high lake levels.

e. Boat wash erosion to dikes at marinas in the Cooley Creek and Wards Canal areas.

f. Possible water quality problems due to additional dike disposal construction as proposed in Toledo Harbor by the Port Authority.

The participants were also asked to contact James H. DeLaPlante III of the Buffalo District by mail or by phone if they thought of other water resources problem areas (shoreline erosion of public lands, flood inundations caused or aggravated by high Lake Erie levels, etc.) after the meeting.

10. Mr. Zorich stated that the Buffalo District is planning to conduct a Public Meeting on the Western Shore study in the spring of 1979. Hopefully, the information provided by interested officials and the general public at the Workshop and upcoming Public Meeting will enable the Corps to establish a study effort along this 50-70 mile reach of Lake Erie consistent with the problem and needs of the affected area and the authorizing resolution for the study.

11. Closing remarks were made by Mr. John Zorich, thanking all present for their participation in the Workshop, and informing participants that copies of the summary minutes of the meeting would be sent to them for information, review, and comments.

12. The meeting was adjourned at 4:30 p.m.

JAMES H. DeLaPLANTE III
Project Manager

ORIENTATION WORKSHOP
FOR
WESTERN LAKE ERIE SHORE FEASIBILITY STUDY, OHIO
WEDNESDAY, 10 JANUARY 1979

ATTENDANCE

Name	Representing
John Zorich, Chief, Western Basin	U.S. Army Corps of Engineers, Buffalo
James H. DeLaPlante III, Project Manager	U.S. Army Corps of Engineers, Buffalo
Joan Pope, Coastal Section	U.S. Army Corps of Engineers, Buffalo
Jon Brown, Economics Section	U.S. Army Corps of Engineers, Buffalo
John Lakatosh, Environmental Section	U.S. Army Corps of Engineers, Buffalo
Albert Fulco, Hydraulics Section	U.S. Army Corps of Engineers, Buffalo
Gary Buck, Regulations Branch, Toledo	U.S. Army Corps of Engineers, Buffalo
Howard W. Hill, Jr.	U.S. Fish and Wildlife Service, Cedar Point
Diane H. Wang, Staff Biologist	U.S. Fish and Wildlife Service, Columbus, Ohio
James Rickenberg	U.S. Soil Conservation Service
Charles Carter	ODNR, Div. Geological Survey, Sandusky
Jonathan Fuller	ODNR, Div. Geological Survey, Sandusky
Fred B. Ball	ODNR, Office of Chief Engineer, Columbus
Dennis Russel	ODNR, Div. of Watercraft, Sandusky
Clifton C. Moore	ODNR, Div. of Watercraft, Sandusky
George Wilson	Lucas County Engineer
James Woodward	Lucas County Drainage Engineer
Carol Butz	Toledo-Lucas County Planning Comm.
William Carstensen	Lucas County Soil & Water Cons. Dist.
Thomas Schultz	Toledo Metropolitan Area, Council of Governments
John Henning	Jerusalem Township Trustee
Richard Smarkel	Jerusalem Township Trustee
Joan Schabel	Jerusalem Township Clerk
Roger Van Hoose	Lake Erie Conservancy, Dist. No. 1
Charles O. Smith	Lake Erie Conservancy, Dist. No. 1
Daniel L. Warner	Howard Farms Conservancy District
Robert Stieben	Howard Farms Conservancy District
Anthony J. Horvath	City of Oregon

ORIENTATION WORKSHOP
FOR
WESTERN LAKE ERIE SHORE FEASIBILITY STUDY, OHIO
WEDNESDAY, 10 JANUARY 1979

ATTENDANCE (Cont'd)

Name	Representing
Niel M. Waterbury	Northwest Ohio National Resource Council
Beatrice J. Waterbury	League of Women Voters
Alice Geisel	Northwest Ohio National Resource Council
Hugh Gunderson	Northwest Ohio National Resource Council
Charles Ginsburg	Northwest Ohio National Resource Council

SUMMARY MINUTES
FOR
ORIENTATION WORKSHOP
ON
WESTERN LAKE ERIE SHORE FEASIBILITY STUDY, OHIO
THURSDAY, 11 JANUARY 1979

1. An Orientation Workshop concerning the Western Lake Erie Shore, Ohio, Study, was held at 1 p.m. on 11 January 1979, at the Oak Harbor Council Chambers, Oak Harbor, Ohio. The study deals with the feasibility of providing for beach erosion control, flood protection, and related purposes in the study area. The purpose of this Workshop was to inform public officials and other principal interests in Ottawa County of the study and to solicit their views on water resources problems and needs in the study area. This input on problems and needs is instrumental in scoping the future study effort and will be incorporated into the Reconnaissance Report currently underway.

2. John Zorich, Chief of the Western Basin, welcomed all present and opened the meeting with self-introduction. Discussion of the Western Lake Erie Shore Study was initiated with a review of the Committee Resolution requested by Honorable Delbert Latta on 11 April 1974. The proposed Corps of Engineers program and study schedule, including progress to date, was then presented and the Corps of Engineers study process was explained in more detail as outlined in an information package that was given to Workshop participants. A list of Workshop attendees is provided at the end of these minutes.

3. Subsequently, Mr. Zorich discussed previous Corps of Engineers studies and completed projects located within the study area. Information was also provided as to current Corps of Engineers activities, namely current studies and authorized projects. Maps of the shoreline area between the Ohio-Michigan line and Marblehead, Ohio, depicting this information was also provided to workshop participants as part of the information package.

4. A brief slide presentation of the shoreline was made by the Project Manager, James H. DeLaPlante III. The purpose of the slide presentation was to acclimate the audience and the Corps Interdisciplinary Team for this study to the geographical and topographical characteristics of the shoreline within the study area, especially the Ottawa County shoreline and problem areas.

5. Mr. Donald Guy of Ohio Department of Natural Resources (ODNR), Geological Survey, explained that a Lake Erie Shore Erosion and

Incl 2

EXHIBIT G4

Flooding Report for Ottawa County is being prepared and should be completed late in 1979. A similar report has been released for Lucas County Erosion and Flood Inundation Problems.

6. Mr. Michael Wolfson from Ottawa Planning Commission explained the CZM program and the program's present status. The Main Coastal Zone Management (CZM) report, of which Ottawa County is a part, is expected to be published in March or April of 1979.

7. Some areas of potential problems were discussed with respect to erosion and flood inundation from high Lake Erie levels and wave runup. Some areas that were identified are:

a. The typical low-lying shore from Locust Point east to the Rock Ledge area on Catawba Island. These low-lying areas experienced flood inundation during the 1972 and 1973 events.

b. The Portage and Toussaint Rivers experience lake effect conditions during high lake levels which affect the interior of Ottawa County, primarily widespread agricultural inundation. Some of the major highways affected by flooding by these river systems are Routes 2 and 590. Because of the lack of relief in the area, flood inundating waters eventually become trapped behind the diking system, thus requiring flooded areas to be pumped out.

c. Hazard to boating at the entrance to Turtle Creek.

d. The northeast corner of Middle Bass Island and at Put-in-Bay where there are some shore erosion problems.

e. The Sand Beach and Long Beach areas are prone to flooding. The county has placed a moratorium on construction in these areas.

f. There are areas of shore erosion all around Catawba Island. However, these areas are all privately-owned residential areas.

g. Port Clinton question of shore placing of dredged material.

The participants were also asked to contact James H. DeLaPlante III of the Buffalo District by mail or by phone if they thought of other water resource problem areas (shoreline erosion of public lands, flood inundations caused or aggrevated by high Lake Erie levels, etc.) after the meeting.

8. Mr. Zorich stated that the Buffalo District is planning to conduct a Public Meeting on the Western Lake Erie Shore Study in the spring of 1979. Hopefully, the information provided by interested officials and the general public at the Workshop and that the

upcoming Public Meeting will enable the Corps to establish a study effort along this 50-70 mile reach of Lake Erie consistent with the problems and needs of the affected area and the authorizing resolution for the study.

9. Mr. Carl Ruff of Ottawa County Cooperative Extension Service, gave a brief slide presentation on the Ottawa County Flooding during the 1972 and 1973 storms.

10. Closing remarks were made by Mr. John Zorich, thanking all present for their participation in the Workshop, and informing participants that copies of the summary minutes of this meeting would be sent to them for information, review, and comments.

12. The meeting adjourned at 4 p.m.

JAMES H. DeLaPLANTE III
Project Manager

ORIENTATION WORKSHOP
ON
WESTERN LAKE ERIE SHORE FEASIBILITY STUDY, OHIO
THURSDAY, 11 JANUARY 1979

ATTENDANCE

Name	Representing
John Zorich, Chief, Western Basin	U.S. Army Corps of Engineers, Buffalo
James H. DeLaPlante III, Project Manager	U.S. Army Corps of Engineers, Buffalo
Joan Pope, Coastal Section	U.S. Army Corps of Engineers, Buffalo
Jon Brown, Economics Section	U.S. Army Corps of Engineers, Buffalo
John Lakatosh, Environmental Section	U.S. Army Corps of Engineers, Buffalo
Albert Fulco, Hydraulics Section	U.S. Army Corps of Engineers, Buffalo
John McCarthy, Resident Engineer, Toledo Office	U.S. Army Corps of Engineers, Buffalo
Gary Buck, Regulations Branch, Toledo	U.S. Army Corps of Engineers, Buffalo
Howard W. Hill, Jr.	U.S. Fish and Wildlife Service Cedar Point
Diane H. Wang, Staff Biologist	U.S. Fish and Wildlife Service Columbus, Ohio
Robert Ball	U.S. Soil Conservation Service
Doyle F. Sommer	U.S. Soil Conservation Service
Donald Guy	ODNR, Div. Geological Survey Sandusky
Carl Hopfinger	ODNR, Div. Geological Survey Sandusky
Carl F. Ruff	Cooperative Extension Service
Michael Wolfson	Ottawa Regional Planning Commission
John Banghman	Ottawa County Health Department
Willard Bloom	Mayor, Oak Harbor
Lauren Milbrodt	Benton Township Trustee
Marvin Tabbert	Benton Township Trustee
William Hirt	Danbury Township Trustee
William Fritz	Catawba Island Trustee
Francis M. Burkhart	Catawba Island Trustee
Paul H. Rofkar	Catawba Island Trustee
William L. Darr	Bay Township Trustee
Charles Hopfinger	Bay Township Trustee
Marian J. Sinkey	Sand Beach Conservancy District

DISPOSITI)N FORM

For use of this form, see AR 340-15, the proponent agency is TAGCEN.

REFERENCE OR OFFICE SYMBOL	SUBJECT		
NCBED-PW	Western Lake Erie Shore, Ohio Flood Damage Prevention Study Lucas Co. & Ottawa Co. Field Recon 2-5 Oct 1978		
TO File: NCBED-PW	FROM J. H. DeLaPlante	DATE 17 Oct 78 DeLaPlante/2294/mas	CMT 1

1. The following memo is in summary of reconnaissance work performed by J. H. DeLaPlante and D. Clark along the western Lake Erie shoreline primarily Lucas and Ottawa Counties for the period of 2 October to 5 October 1978.

2 October 1978

a. Upon arrival, approximately 10:15 a.m. in the Detroit Airport, J. H. DeLaPlante and D. Clark met Mr. Gary Buck of the Toledo Branch office. We proceeded to a small aircraft airport in the Toledo vicinity and boarded a Cessna 185 seaplane to begin the aerial view of the entire western Lake Erie shoreline. After approximately 2-1/2 hours, the plane landed in Port Clinton. Mr. Gary Buck, J. H. DeLaPlante, and D. Clark ~~went~~ [illegible] to the Lakefront Marina located west of Port Clinton. Lakefront Marina is requesting a permit to extend their existing jetties into the lake for the purpose of preventing the accumulation of sand at the mouth of the marina entrance channel.

b. We then proceeded to the Port Clinton Yacht Club to investigate the club's channel opening. The water depth at the opening continues to be more shallow due to sand and silt accumulations from the lake and Portage River. The primary discussion with the club members was in both structural and nonstructural alternatives that could be undertaken by the club. Included in the discussion were the costs of dredging the channel opening every three to four years.

c. After this meeting we again boarded the plane at Port Clinton and continued the aerial reconnaissance along the Lake Erie shoreline east to approximately Lorain, Ohio. The flight included the Lake Erie islands and the two counties' estuaries. The aerial reconnaissance was completed at approximately 7:00 p.m.

3 October 1978

a. After picking up rental car at Detroit Airport for the purpose of continuing the mission, it was found that John Zorich and Kesavaro Yalamanchili had cancelled their plans. J. H. DeLaPlante and D. Clark proceeded in carrying out the scheduled itinerary and began with a visit of the proposed Maumee State Park site. A total reconnaissance of the area was performed, keeping in mind the possible involvement the Corps may have on beach erosion control and flood protection. Refer to photos taken describing the area.

b. In addition to the Maumee State Park, a site visit was performed at the Reno Beach-Howard Farms area.

4 October 1978

a. An a.m. meeting was scheduled with the Lucas County Engineer, Mr. George Wilson. Lucas County problem areas were discussed with George Wilson, Jim Woodward

DA FORM 1 FEB 62 2496 REPLACES DD FORM 96, WHICH IS OBSOLETE. ☆GPO-1976-665-422/1063

EXHIBIT G5

and Roy Lunceford prior to site visit. The following areas were pointed out as problem areas by the Lucas County officials:

(1) Wards Canal - erosion of westerly dike enclosing Reno Beach-Howard Farms area primary cause from boat wash from marina.

(2) Overland flooding and flooding due to high Lake Levels in the Bono area.

(3) Oregon Pumping Station - Potential flooding & erosion area (near Anchor Point)

(4) Harbor view and Bay Shore area - no flood protection - potential flooding problem.

(5) Lost Peninsula - Ohio side of peninsula is protected however, Michigan side north on peninsula, no protection.

(6) Waterville - Maumee River high water problems with flooding in low land areas.

(7) Erosion to River Road due to ice jamming near side cut Metropark and State Road 23.

b. All the above areas were visited and described by photograph.

5 October 1978

a. Another a.m. meeting was scheduled to discuss similar problems as Lucas County with the Ottawa Regional Planning Commission. Present were representatives from U. S. Soil Conservation, Winous Shooting Club and the Ottawa Cooperative Extension Service.

Terry Horvath

b. The following Ottawa County problem areas were discussed prior to the site visits:

(1) Sand Beach

(2) Camp Perry

(3) Shoreline west of Port Clinton

(4) Shore protection provided at Rock Ledge on Catawba Island

NCBED-PW
SUBJECT: Western Lake Erie Shore, Ohio Flood Damage Prevention Study
Lucas Co. and Ottawa Co. Field Recon 2-5 Oct 1978

(5) East Harbor State Park

(6) Shore erosion in Sandusky Bay by Gypsum Plant and Oak Harbor area.

(7) Winous Shooting Club (private) dike construction

(8) Typical house on Sandusky Bay - shore erosion

c. All the above areas were photographed and described.

2. County participants during 4 and 5 October Field Reconnaissance:

Lucas County

George F. Wilson - County Engineer	(419)259-8620
Jim Woodward - Drainage Engineer	(419)259-8625
Roy L. Lunceford - Director, Civil Defense	(419)259-8746

Ottawa County

Mikael Wilfson - Ottawa Regional Planning Commission	(419)734-2153
Robert Ball - U. S. Soil Conservation Service	(419)898-6431
Doyle Sommer - U. S. Soil Conservation Service	(419)898-6431
Carl F. Ruff - Cooperative Extension Service	(419)898-3631
Robert D. Hoffman - Winous Point Shooting Club	(419)734-2153

JAMES H. DELAPLANTE

NCBED-PW 16 November 1979

MEMORANDUM FOR RECORD

SUBJECT: Western Lake Erie Shore Trip Report 6 November Through 8 November 1979

1. Participants

John Zorich
Tony Eelman
Brian Troyer (Reno Beach only)

2. The purposes of this trip were:

a. To hold an orientation workshop beginning the Phase I GDM for Reno Beach;

b. To investigate flood and erosion problem areas in Lucas County identified by local interests at the orientation meeting held on 10 January 1979 and from subsequent letters received;

c. To investigate at the request of Congressman Latta a problem on the Maumee River identified by one of his constituents.

d. To survey the Maumee State Park Beach area.

3. An orientation workshop beginning the Phase I GDM study for Reno Beach was held at Jerusalem Township Hall on 6 November 1979. A separate report on this meeting will be prepared by J. Zorich who chaired the workshop.

4. The flood and erosion problem areas identified by local interest on the Western Lake Erie Shore Study in Lucas County were:

a. Flooding in Bono

b. Shoreland Road Flooding

c. City of Oregon Flooding

EXHIBIT 96

NCBED-PW
SUBJECT: Western Lake Erie Shore Trip Report 6 November Through 8 November 1979

d. Oregon Water Intake

e. Reno Beach & Howard Farms

(1) Flooding in Bono - George Wilson, Lucas County Engineer, stated that the flooding at Bono was the result of high lake levels which would cause Ward's Canal in the Howard Farms area to overflow and inundate the Bono area. However, he indicated that no serious flooding has ever occurred in this area. A tour of the area revealed that a protective high embankment was on the Howard Farms side of Ward's Canal and none on the Bono side. Damage investigation and possibly damage surveys will have to be performed before any protective measures can be considered to establish Federal interest.

(2) Shoreland Road Flooding - Shoreland Road is located along the Ottawa River in Washington Township. The flooding reported occurs along Shoreland Road between River Road and the Ohio-Michigan border. There are very expensive homes along this reach indicating flooding could cause costly damages. Evidently, high lake levels associated with wind generated waves create the problems. It should be noted that Point Place, a floodprone area, is located just across from the Shoreland Road area. No contact with a Washington Township official could be made because of the late hour this area was surveyed. Contact will be made for damage information.

(3) City of Oregon Flooding - There are two areas in the city of Oregon that were identified as flood and erosion problem areas - Bay Shore Road and Harbor View areas. Anthony Horvath, Assistant Supervisor of the city of Oregon, gave us a tour of the area, and provided us with a flood insurance study that was performed by HUD. The harbor view was not considered much of a problem due to its proximity to inland coves. The Bay Shore Road area was extensively flooded during high lake levels and winds. It is comparatively heavily populated and unprotected in many areas. During Operation Foresight, protection in this area was refused by local residents, because they did not want dikes along their lakefront. The flood insurance data we received from Mr. Horvath will be examined for usable content.

(4) Oregon Water Intake - The Oregon Water Intake is located along the lake shore just west of Reno Beach. During Operation Foresight a dike was constructed around the water intake structure, but about 500 feet of the access road is below flood stage. The problem is that access to the water intake structure could be lost

during periods of high water. It was our observation that if this condition occurred and vehicular traffic could not gain access to the pumping station, a boat could be used. A conversation with two Water Department employees at the site indicated that the access road was never flooded to an elevation that prevented them from driving through, and they have never had any problems with the pumping facilities. Therefore, it is our opinion that no additional protective measures are warranted at this time. However, as the WLES study progresses, and additional information is obtained, it is possible that protective measures could be justified before the completion of this report.

(5) Reno Beach and Howard Farms - As stipulated earlier, a Phase I GDM has been initiated to study these areas.

Other less critical problem areas identified were erosion at the Anchor Point Marina (privately owned), erosion of the State-owned Metzer Marsh, and dike maintenance at Little Cedar Point. These areas will be checked in future field trips.

5. Congressman Latta forwarded a letter from M. Swihart, a constituent, who complained of flooding caused by ice jams on the Maumee River between Jerome Road and Sidecut Park along River Road. According to M. Swihart, houses are damaged and farm crops are destroyed. A survey of the area revealed that about 30 percent of the area was farmland and we could find only one home could suffer flood damage. A previous conversation with Mr. Wilson, County Engineer, indicated that this ice jamming on the Maumee River does not always occur and when it does, it does not always happen in this area. Therefore, we must conclude it is not a yearly occurrence. Personal contact with M. Swihart was not attained, because of his school hours. In a phone conversation with him on 8 November, we told him he would be contacted by his Congressman on this problem in the near future. J. Zorich concluded that existing development is compatable with the flood potential, that economic justification of a flood control project would be highly unlikely, and recommended that Buffalo District FPMS inform Congressman Latta that a Reconnaissance Report for the area is not warranted.

6. John Zorich and I walked the beach area of the Maumee State Park. There was some dirty sand and organic material, but the beach was mostly composed of a dense clay. Erosion was evident along the shore area where the land met the beach dropping vertically from 2 to 3 feet. It was our opinion that this area is not the most desirable

NCBED-PW
SUBJECT: Western Lake Erie Shore Trip Report 6 November Through 8 November 1979

location for a swimming beach. However, these problems could probably be eliminated through proper design and we will continue on with the feasibility study by A/E contract.

ANTHONY R. EELMAN

WESTERN LAKE ERIE SHORE FIELD TRIP - 8 JANUARY THROUGH 10 JANUARY 1980

PURPOSE

To observe and gather information for the Western Lake Erie Shore Reconnaissance Report. Specific areas covered were Washington Township, the City of Oregon, and Ottawa County.

DISCUSSION

WASHINGTON TOWNSHIP

Flooding was identified in Washington Township along Shoreland Drive paralleling the Ottawa River between Summit Street and the Ohio-Michigan border in the Toledo metropolitan area. The homes in this community are all in the $80,000 to $100,000 range. The only local officials are three members of a Board of Trustees located on David and Blessink Streets. These persons are not available during the day, because it is a part-time effort. I found a local policeman who gave me the name of one of the trustees (Rod Poddany). I attempted to contact him after 5 pm, but was unsuccessful.

To determine the extent of the flooding I interviewed a few residents of Shoreland Drive. From my conversations and observation, I came up with a rough flood line as shown on inclosure 1. I noted that two homes had earth mounds around their property and one had a concrete wall about one foot high. The area was flooded three times since 1965 from the Ottawa River. Surveys would have to be performed to determine more definite flood damages. It is estimated that approximately twenty homes experience flooding to some degree.

In order to protect these structures, dikes would be required along the Ottawa River shoreline such as those at Point Place across the river. In order to be effective, these dikes would have to be extended northward into Michigan which is not covered by this authorization. From my conversation with residents they would not be agreeable to a stone dike along their backyards. They would rather put up with some periodic flooding. It is doubtful that any project could be justified for 20 [redacted] homes, but I will attempt to obtain more detailed information from Rod Poddany, a trustee of Washington Township.

OREGON

The South Shore Park area of the city of Oregon has experienced flooding in the past (Inclosure 2). During "Operation Foresight" this area was eligible for a project but the necessary easements could not be obtained. Evidently, riparian owners objected to a large dike obstructing their view of the lake. I spoke with W.J. Gross, Director of Public Safety and Service for the City of Oregon, concerning this problem. He wasn't sure how the Lake Shore Park Area residents would feel about a project now - seven years later, but indicated there would be some problems in obtaining easements.

EXHIBIT G 7.

Since we had damage surveys done, we will compute a rough BCR ratio to determine if any project is justified. However, if a project appears justified, we must determine at the forth coming public meeting if we will have any difficulties in obtaining easements. If so, further investigation of a project at Lake Shore Park will be discontinued.

OTTAWA COUNTY

In a letter dated 16 FEB 79 (Inclosure 3), John Papcun, Ottawa County engineer, requested that the Corps examine the possibility of repairing, extending, and building new jetties along the Lake Erie coast in Ottawa County. The identified jetty work at Turtle Creek, Brough Creek, Toussaint River, and LaCarpe Creek would aid in some erosion control, but would not alleviate any flooding conditions. Inspection of these sites revealed heavy marina activity, which indicates that any benefit evaluation would rely heavily on recreational activities. This type of improvement would better be accommodated by the Lake Erie Coast Small Harbor Study.

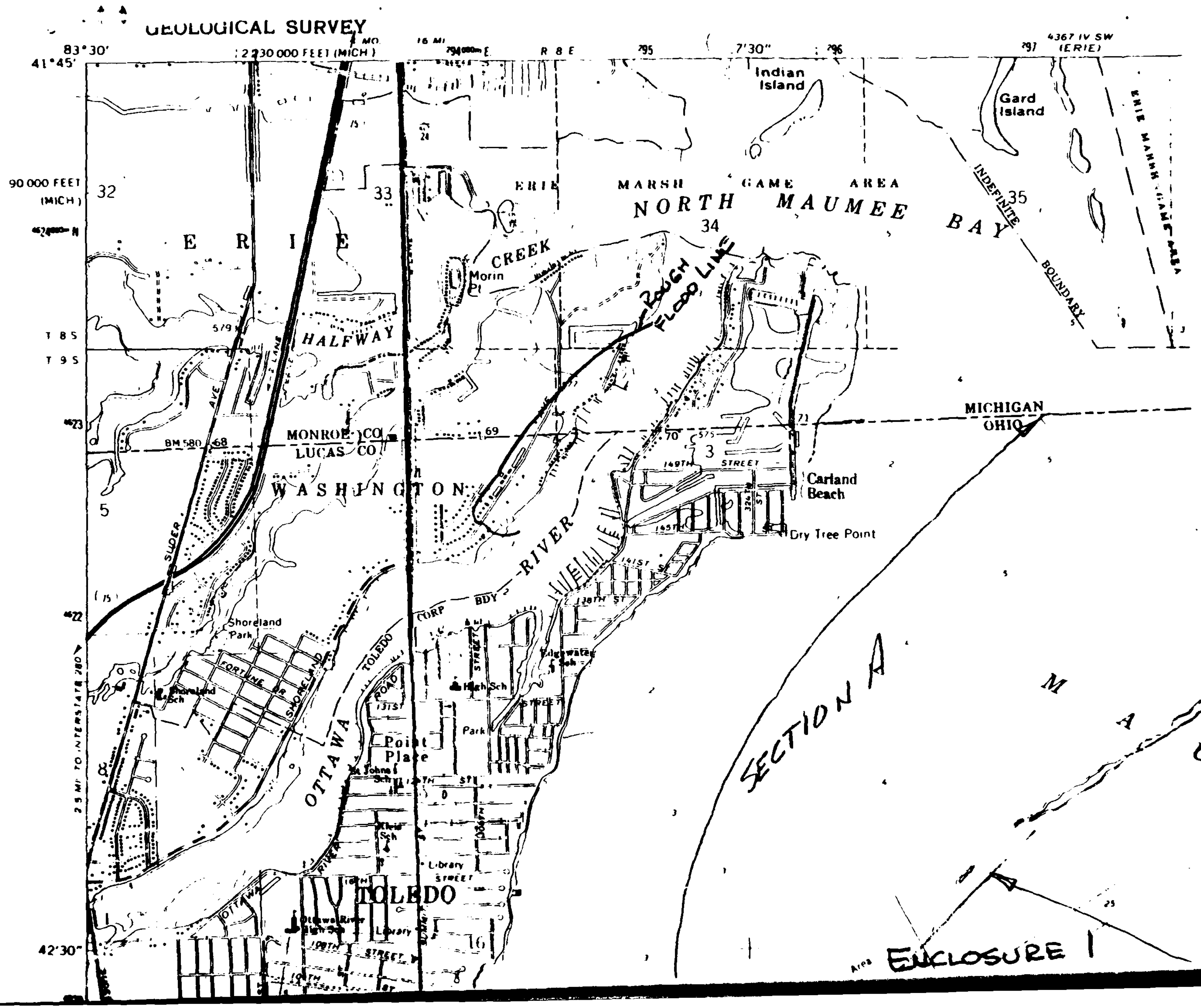
I met with John Papcun to obtain information on other identified problems. The proposed jetties west of the Portage River outlet would also include a new river and harbor outlet and a fifty foot vertical clearance bridge. The purpose of this modification would be to relieve the present Route 163 draw bridge spanning the Portage River. It is old and rapidly deteriorating according to Mr. Papcun (see inclosure 4).

Another identified problem is the need for small jetties (groins) along the Park area in Port Clinton to build up the swimming beach. This area is also subjected to floods and erosion which could be covered under this authority. Damage surveys have been accomplished here and benefit evaluations are in progress. Groins may or may not be a solution depending on whether littoral drift or off-shore, on-shore are prevalent. Further studies will be conducted (see inclosure 5).

Mr. Papcun also suggested that the jetty improvements from Turtle Creek to Port Clinton could act as one large set of groins to protect this whole shoreline. I have some reservations on this concept, but will consult with Coastal.

Flood and erosion problems are a common occurrence at Long Beach and Sand Beach areas. Mr. Papcun indicated that a project was investigated by the Detroit District some years ago, but nothing could be justified. Because of this situation, he initiated a Flood Plain Management Program. No structures are permitted to be built below the 100-year flood plain. An inspection of the area disclosed that most of the structures along the shore area are summer cottages along the western portion of Long Beach and most of Sand Beach. More expensive structures were found in the Eastern half of Long Beach. These are mostly occupied. Many of the cottages and homes along the shoreline have some sort of makeshift protection against erosion. Since this area is quite populated, further studies may be warranted if the Lake Shore Park Area in Oregon and Port Clinton Benefit-Cost evaluations prove justified (see inclosure 6).

TONY EELMAN
Project Manager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Gard Island
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E R I E
CREEK
Morin Pt
HALFWAY
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T 9 S
ROUGH FLOOD LINE
MICHIGAN
OHIO
MONROE CO
LUCAS CO
WASHINGTON
RIVER
Carland Beach
Dry Tree Point
149TH STREET
CORP BDY
SUDER AVE
Shoreland Park
FORTUNE DR
SHORELAND
TOLEDO ROAD
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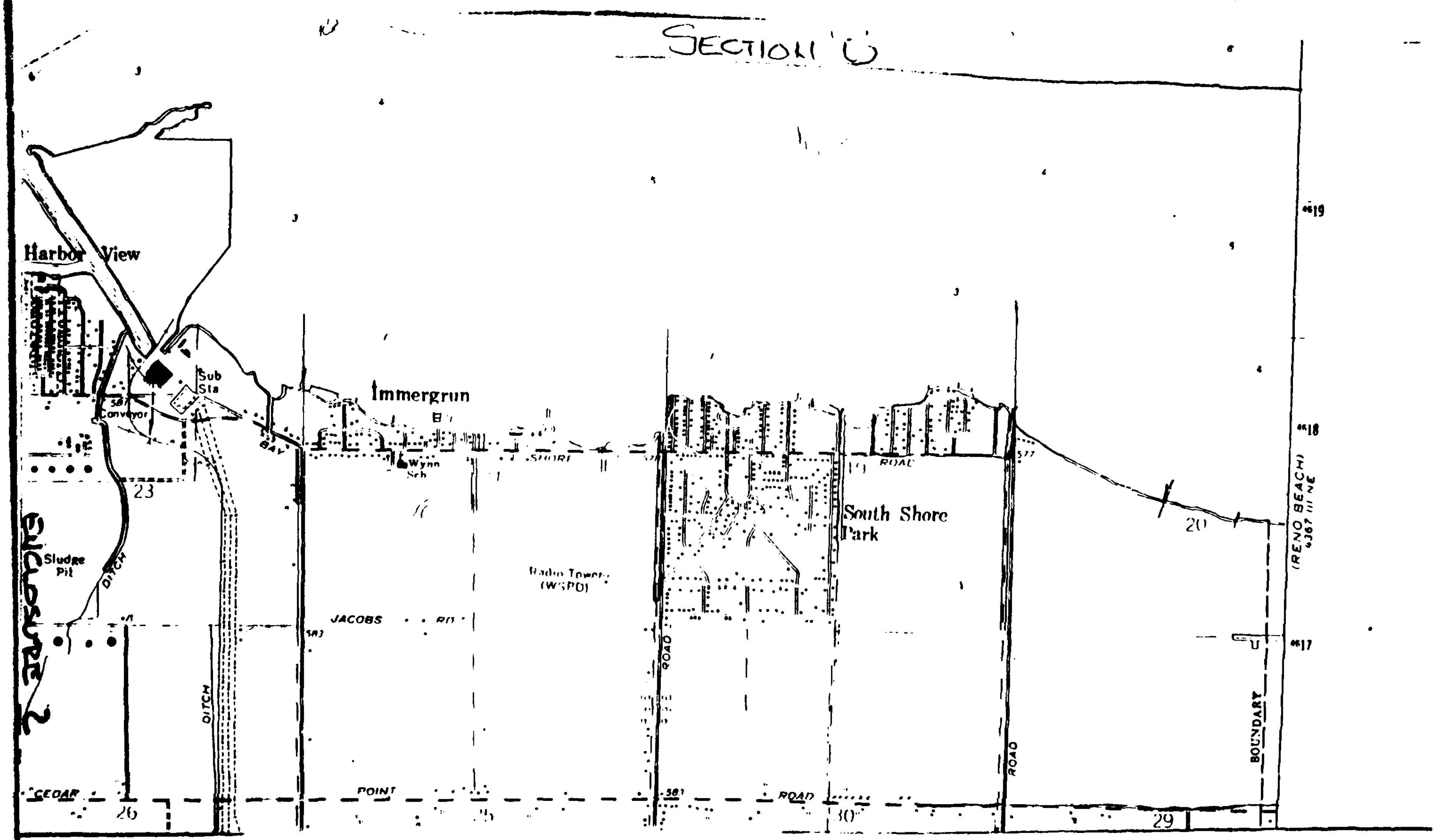
SECTION 'C'
Harbor View
Sub Sta
Conveyor
Immergrun
Wynn Sch
SHORE
ROAD
South Shore Park
Radio Tower (WSPD)
JACOBS RD
ROAD
ROAD
DITCH
DITCH
Sludge Pit
CEDAR POINT ROAD
BAY
BOUNDARY
(RENO BEACH) 4367 III NE
19
18
17
20
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26
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30
29
ENCLOSURE 2

OFFICE OF
OTTAWA COUNTY ENGINEER
COURTHOUSE
PORT CLINTON, OHIO 43452

JOHN G. PAPCUN, P.E.
COUNTY ENGINEER

(419) 734-3174
734-3175

February 16, 1979

Department of the Army
Buffalo District, Corps of Engineers
1776 Niagara Street
Buffalo, New York 14207

Attention: Daniel D. Ludwig, P. E., Colonel, Corps of Engineers

Re: Western Lake Erie Shore Study

Dear Colonel Ludwig:

Relative to your Orientation Workshops of January 10 and 11, 1979 and your letter of February 12, 1979, I offer the following comments.

After the 1972 and 1973 floods, the Corps studied many areas in our county for flood control projects. The only project that was feasible was in Bay Township and was built by your district. We realize it is difficult to achieve a benefit-cost ratio for flood control projects. However, we further believe benefit-cost ratios may be substantiated for jetty projects as shown on the enclosed map. A similar map was submitted to your office and the Detroit District in 1973.

The proposed jetties at creek or river outlets would be relatively inexpensive compared to the benefits derived such as reduced erosion, reduced wave damage, better drainage, increased protection for boaters during storms and expansion of inland boat marinas. Some of the jetties built during W.P.A. days have been neglected and are practically non-existent. We would at least like to see a benefit-cost ratio study made of the noted locations.

I would also like to know the status of the Black Rock Dam and lock proposal at Buffalo to help control the Lake Erie water levels. It would seem to me that the benefit-cost ratio of this project would make it the number one priority project on Lake Erie providing Canada would agree.

Thank you for the opportunity to make comments and for your continued cooperation.

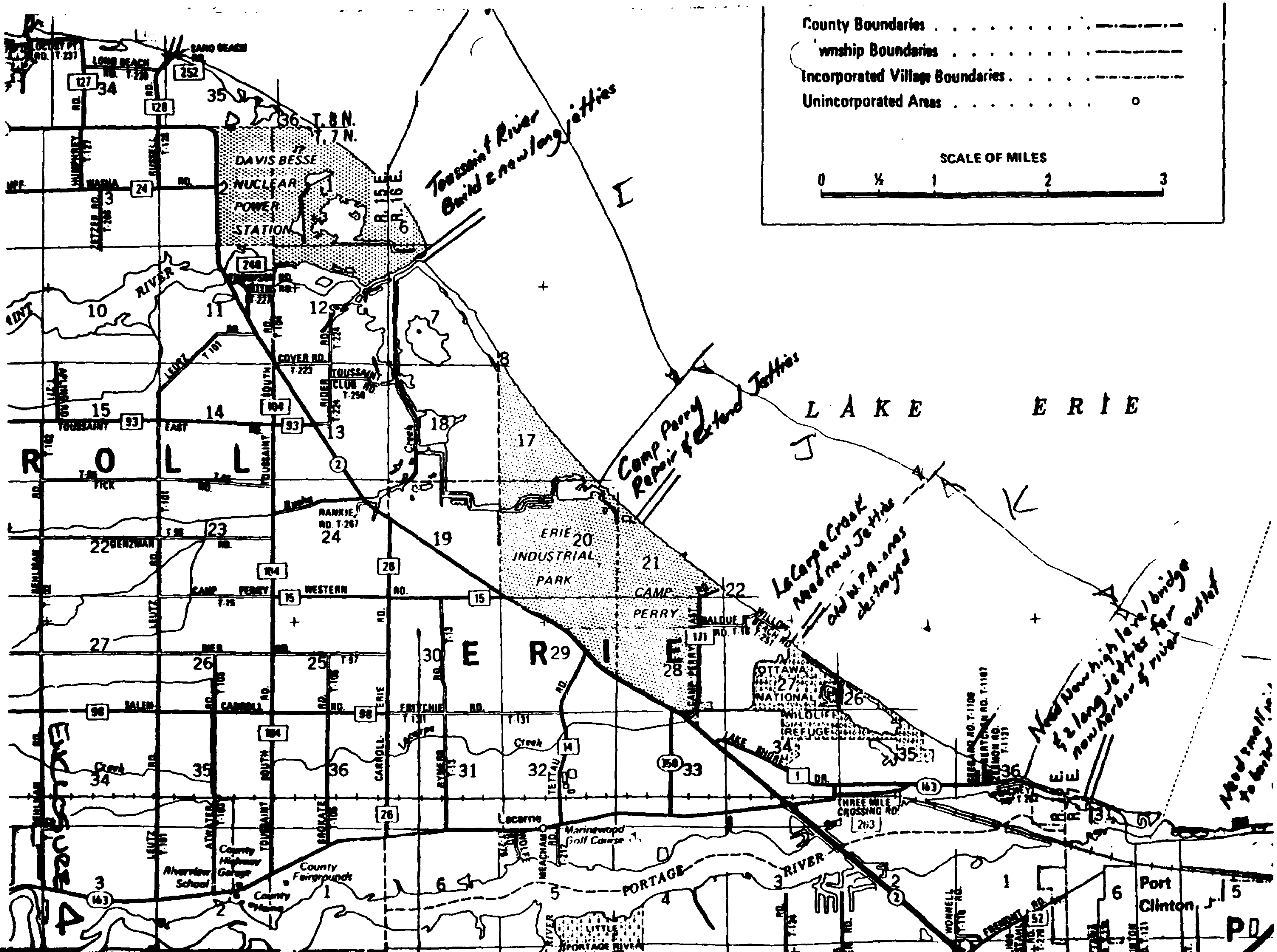
Very truly yours,

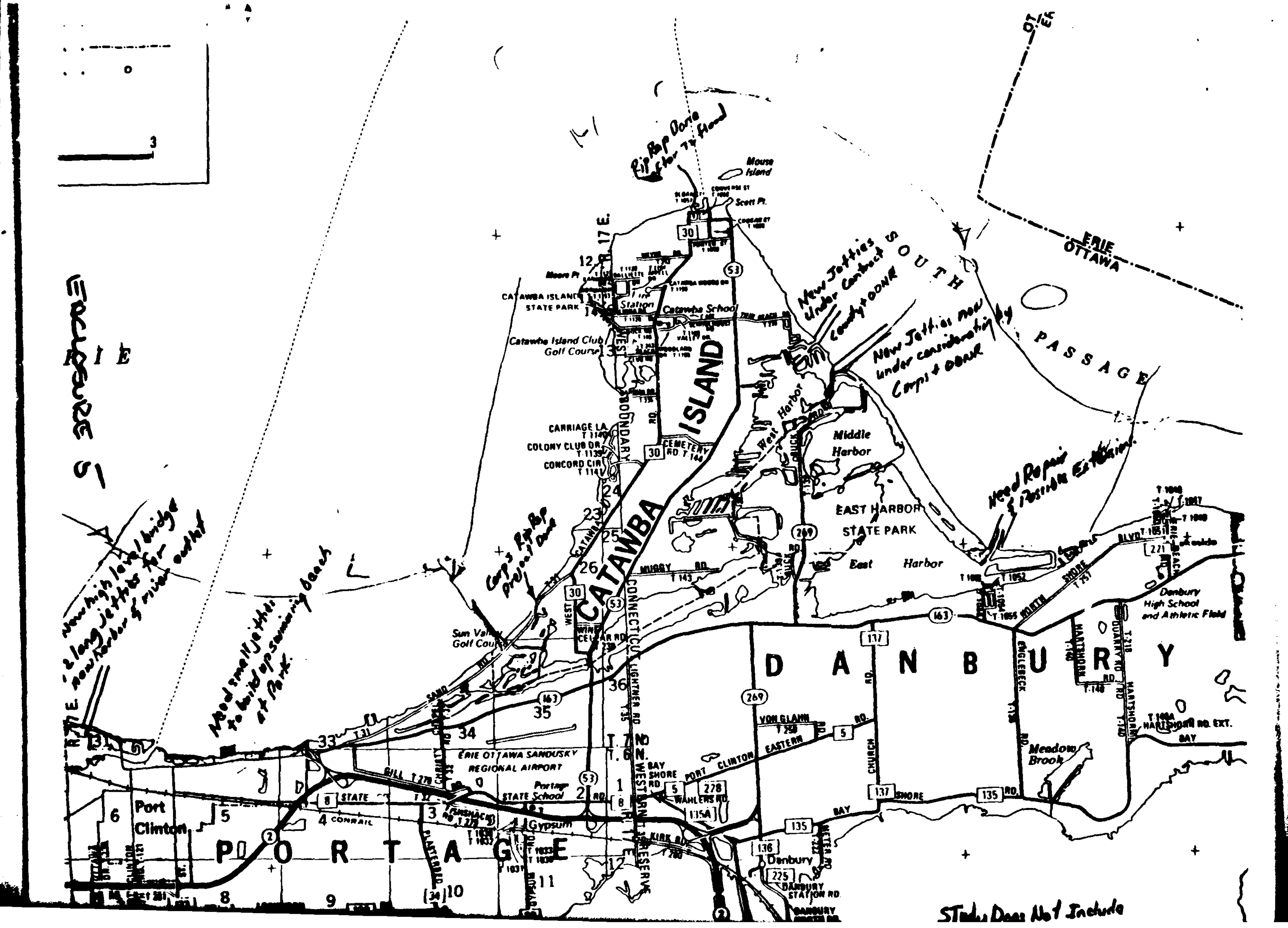
John G. Papcun

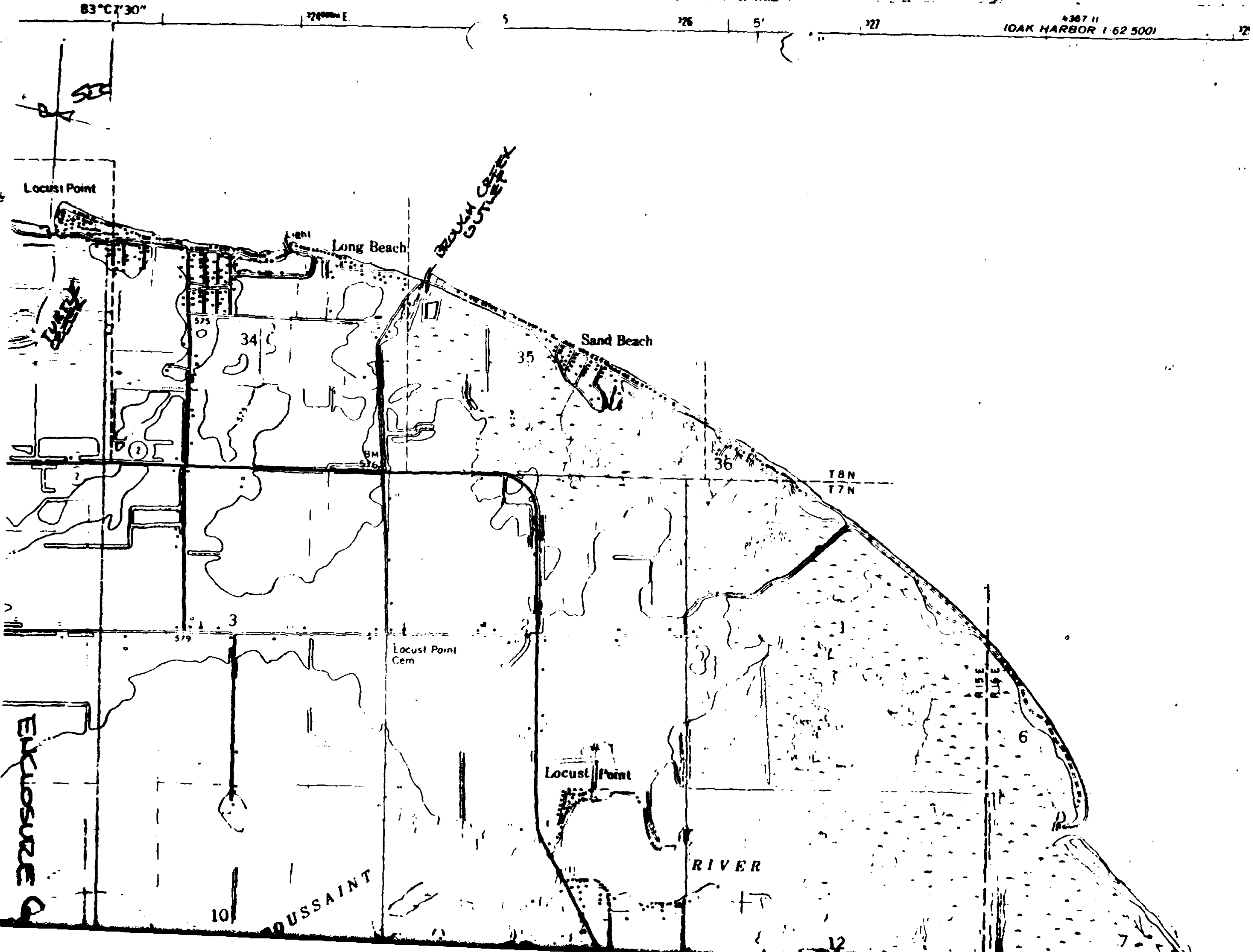
John G. Papcun,
Ottawa County Engineer

JGP/db

ENCLOSURE


County Boundaries
wnship Boundaries
Incorporated Village Boundaries
Unincorporated Areas
SCALE OF MILES
0 ½ 1 2 3
LAKE ERIE
DAVIS BESSE NUCLEAR POWER STATION
ERIE INDUSTRIAL PARK
CAMP PERRY
OTTAWA NATIONAL WILDLIFE REFUGE
PORTAGE RIVER
Port Clinton
ROLL
ERIE
T. 8 N.
T. 7 N.
R. 15 E.
R. 16 E.
Toussaint River
Build 2 new long jetties
Camp Perry
Repair & Extend Jetties
LaCarpe Creek
Need new Jetties
old W.P.A. ones destroyed
Need New high level bridge
& 2 long jetties for new harbor & river outlet
Need small ...
to build
ENCLOSURE 4


ENCLOSURE 5
Rip Rap Done after 73 Flood
Mouse Island
Scott Pt.
Moore Pt.
CATAWBA ISLAND STATE PARK
Catawba Island Club Golf Course
Catawba School
CATAWBA ISLAND
CARRIAGE LA.
COLONY CLUB DR.
CONCORD CIR.
CEMETERY RD.
BOUNDARY
WEST
MUGGY RD.
WINE CELLAR RD.
CONNECTICUT WESTERN RESERVE
LIGHTNER RD.
New Jetties Under Contract County + ODNR
New Jetties now under consideration by Corps + ODNR
SOUTH PASSAGE
ERIE
OTTAWA
West Harbor
Middle Harbor
EAST HARBOR STATE PARK
East Harbor
Need Repair & Possible Extension
Corps's Rip Rap Project Done
Sun Valley Golf Course
Need small jetties to build up swimming beach at Park.
New high level bridge & long jetties for new harbor of river outlet
ERIE OTTAWA SANDUSKY REGIONAL AIRPORT
Portage State School
Gypsum
Port Clinton
PORTAGE
DANBURY
Danbury High School and Athletic Field
Meadow Brook
VON GLAHN
PORT CLINTON EASTERN
ENGLEBECK RD.
CHURCH RD.
HARTSHORN RD.
QUARRY RD.
NORTH SHORE BLVD.
BAY SHORE RD.
WAHLERS RD.
KIRK RD.
CONRAIL
STATE
GILL
CHRISTY
PLASTERBED
Danbury
DANBURY STATION RD.
Study Does Not Include



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Sand Beach
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3
Locust Point Cem
Locust Point
RIVER
10
6
7
12
R15E
R16E

ENCLOSURE G

SUMMARY OF PRELIMINARY FINDINGS
LAKE ERIE REGULATION STUDY
August 1980

1. Introduction

This summary of the preliminary findings of the International Lake Erie Regulation Study Board is intended to acquaint the public with the study background, progress and results. Anyone attending the Fall 1980 public meetings will have an opportunity to comment on these findings prior to the Board formulating its recommendations. A summary of the meetings together with the opinions expressed by those attending will be included in the Board's final report to the International Joint Commission (IJC) in early 1981.

2. Background

In 1977, the International Joint Commission established a study board to determine the possibilites for limited regulation of Lake Erie, taking into account the applicable Orders of Approval of the Commission and the recommendations of the Canada-Quebec Study of flow regulation in the Montreal region. The study came about as a result of the IJC's recommendation to the Governments in its 1976 Report "Further Regulation of the Great Lakes," and because of record high levels in the early 1970's. The Study Board was directed to investigate the types of control works and remedial works that would be required to carry out limited regulation of Lake Erie, the costs of these works, and the probable effects of Lake Erie regulation throughout the Great Lakes Basin, including the St. Lawrence River.

3. Purpose and Scope

Limited regulation of Lake Erie requires increasing its outflows, according to certain prescribed rules, through control works constructed at the head of the Niagara River. The study consists of several major tasks as follows: a) development of plans for increasing the outflow from Lake Erie; b) identification of the types of control works required in the Niagara River, as well as further works that could be required in the St. Lawrence River to accommodate increases in Lake Erie outflow; c) evaluation of the probable effects of limited Lake Erie regulation on the water levels and outflows of all the Great Lakes and on the major economic and environmental interests; and, d) comparison of the benefits and costs to determine feasibility of limited Lake Erie regulation. The major economic interests are coastal zone, commercial navigation, hydro-electric power, recreational beaches and boating.

The geographic coverages of most major economic interests extend throughout the Great Lakes-St. Lawrence system. The environmental and recreational effects are being evaluated for the area from Port Huron, Michigan-Sarnia, Ontario, at the head of St. Clair River, to the Quebec-New York border on the St. Lawrence River, with emphasis on the Lake Erie-Niagara River area.

EXHIBIT 98

4. Regulation Plan Development and Hydrologic Evaluation

Lake Erie receives about 80% of its water from the upper Great Lakes. Therefore, conditions on the upper Great Lakes have a major bearing on the water level of Lake Erie. The appropriate time to increase the lake's outflow is when the water supplies to the upper Great Lakes are above average. This would require construction of control works at the head of the Niagara River. When the supply conditions on the upper Great Lakes are at or below average, the control structure at Niagara would have to be adjustable to provide the outflow that would have occurred under natural conditions. The objective, therefore, is to maximize the lowering of the high Lake Erie water levels while maintaining as nearly as possible its long-term average and minimum levels.

All Lake Erie regulation plans developed by the Board were compared to the Basis-Of-Comparison. The Basis-Of-Comparison is a set of water levels and outflows that the Great Lakes system would have experienced for the study period 1900-1976, if the following physical conditions were in effect:

a) Lake Superior regulated in accordance with Plan 1977;
b) Lake Ontario regulated in accordance with Plan 1958-D;
c) average diversion of 5,000 cubic feet per second (cfs) into Lake Superior at Long Lake and Ogoki, 3,200 cfs out of Lake Michigan at Chicago, and 7,000 cfs from Lake Erie to Lake Ontario by way of the Welland Canal; and,
d) present uncontrolled channel outlet conditions in the St. Clair, Detroit and Niagara Rivers.

A series of Lake Erie regulation plans has been developed. From these plans the Study Board has chosen three for more detailed study. One plan requires the use of the Black Rock Lock to increase the Lake Erie outflow. The second plan would divert water from the Black Rock Canal through Squaw Island while the third uses a structure and channel enlargement in the Niagara River. These structures would have annual capacities ranging from 4,000 cfs for the lock scheme to 25,000 cfs for the river structure. These increases in Lake Erie outflow may be compared with the long-term mean Niagara River flow of 200,000 cfs. The locations of these alternative structures are shown in Figure 1.

Table 1 shows the hydrologic effects of the three plans on the levels of the Great Lakes and Lake St. Louis. There would be a general lowering of the maximum levels for Lake Erie under all plans. In addition, there would also be a slight lowering in its mean and minimum levels. Because there is an effect of Lake Erie regulation on Lake Huron, there would also be some lowering effects on the upper Great Lakes. On Lake Ontario, the impacts of Lake Erie regulation would be small on the mean and maximum levels. The minimum levels would be raised slightly.

5. Regulatory Works

Three alternative types of control works were examined (Figure 1). The modification of the Black Rock Navigation Lock would permit increases in Lake Erie outflow of up to 4,000 cfs annually. A diversion channel, equipped with a control structure on Squaw Island, would provide an annual outflow increase of 10,000 cfs. A control structure in the Niagara River

FIGURE 1

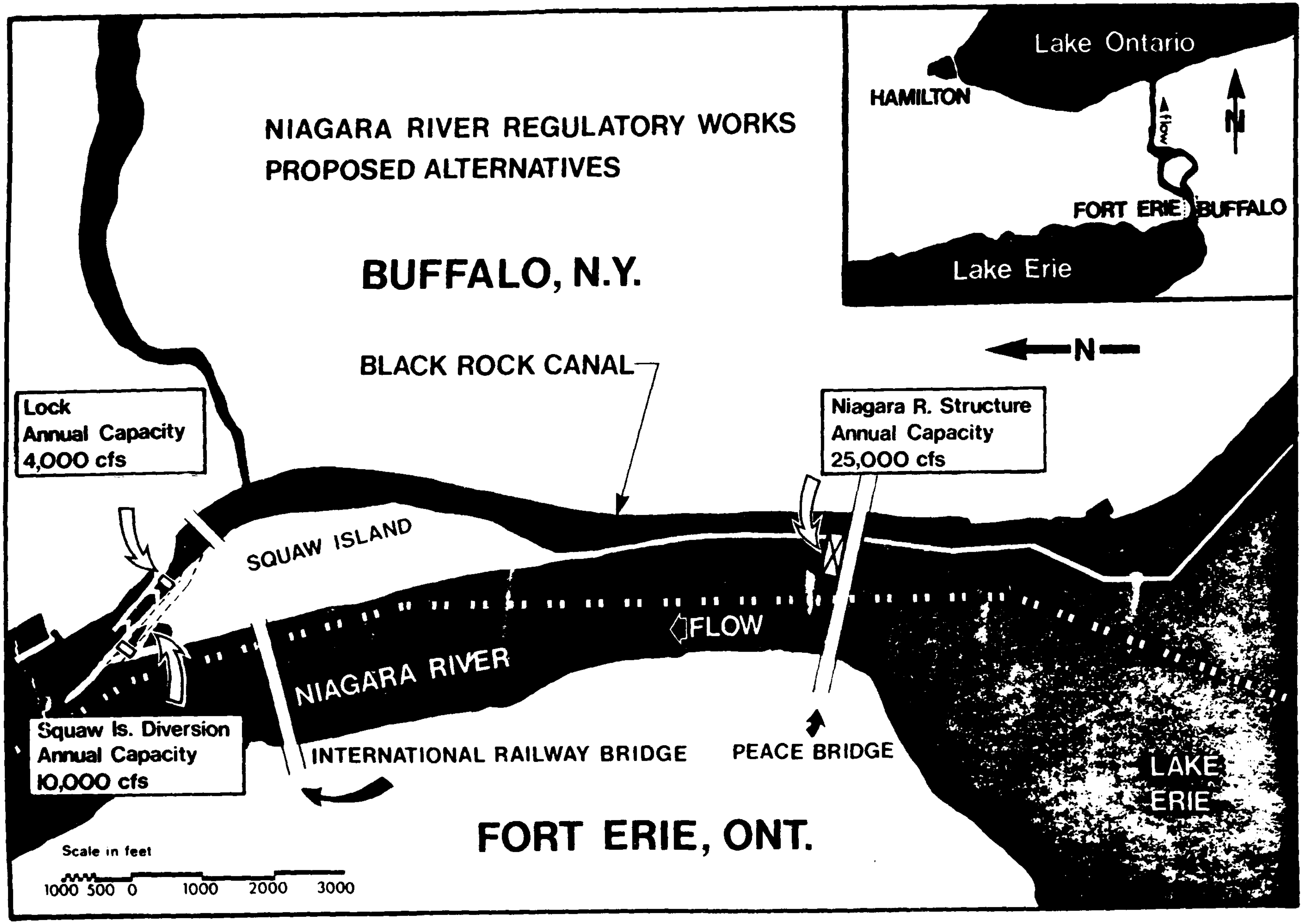

NIAGARA RIVER REGULATORY WORKS
PROPOSED ALTERNATIVES
BUFFALO, N.Y.
BLACK ROCK CANAL
Lake Ontario
HAMILTON
flow
N
FORT ERIE
BUFFALO
Lake Erie
N
Lock
Annual Capacity
4,000 cfs
Niagara R. Structure
Annual Capacity
25,000 cfs
SQUAW ISLAND
FLOW
NIAGARA RIVER
Squaw Is. Diversion
Annual Capacity
10,000 cfs
INTERNATIONAL RAILWAY BRIDGE
PEACE BRIDGE
LAKE ERIE
FORT ERIE, ONT.
Scale in feet
1000 500 0 1000 2000 3000

Table 1 Hydrologic Evaluation of Lake Erie Regulation Plans
STAGES IN FEET IGLD (1955)

	BASIS OF COMPARISON*	LAKE ERIE REGULATION PLANS		
		BLACK ROCK LOCK (4,000 cfs)	SQUAW ISLAND DIVERSION (10,000 cfs)	NIAGARA RIVER STRUCTURE (25,000 cfs)
Lake Superior				
Mean	600.4	600.4	600.4	600.4
Maximum	601.9	601.9	601.9	601.9
Minimum	598.7	598.7	598.6	598.6
Range	3.2	3.2	3.3	3.3
Lakes Mich-Huron				
Mean	578.3	578.2	578.2	578.0
Maximum	581.2	581.1	581.0	580.8
Minimum	575.5	575.4	575.4	575.4
Range	5.7	5.7	5.6	5.4
Lake Erie				
Mean	570.8	570.7	570.5	570.2
Maximum	573.6	573.4	573.2	572.5
Minimum	568.1	568.1	568.0	567.8
Range	5.5	5.3	5.2	4.7
Lake Ontario				
Mean	244.6	244.6	244.7	244.7
Maximum	247.4	247.3	247.4	247.4
Minimum	241.8	242.0	242.1	242.2
Range	5.6	5.3	5.3	5.2
Lake St. Louis				
Mean	68.0	68.0	68.0	68.1
Maximum	72.9	73.1	73.1	73.0
Minimum	65.4	65.6	65.4	65.2
Range	7.5	7.5	7.7	7.8

* The Basis-Of-Comparison was computed based on present uncontrolled channel outlet conditions in the St. Clair, Detroit and Niagara Rivers; Lake Superior regulated in accordance with Plan 1977; Lake Ontario regulated in accordance with Plan 1958-D; average diversion of 5,000 cfs into Lake Superior at Long Lac and Ogoki; 3,200 cfs out of Lake Michigan at Chicago; and 7,000 cfs from Lake Erie to Lake Ontario by way of the Welland Canal.

would provide an annual outflow increase of 25,000 cfs. The costs of these structures are summarized below.

NIAGARA ALTERNATIVES	ANNUAL CAPACITY (cfs)	FIRST COST ($ million)	OPERATION and MAINTENANCE ($ million)	TOTAL COST ($ million)
Black Rock Lock	4,000	10.3	1.6	11.9
Squaw Island	10,000	19.6	2.0	21.6
Niagara River Structure	25,000	111.4	3.9	115.3

NOTE--All cost figures converted to present value at 8-1/2% interest rate and are based on July 1979 price level and a project life of 50 years.

The lowering of Lake Erie would be achieved by increasing its outflow. While this could be done without increasing the maximum water level of Lake Ontario, it would increase the frequency and duration of high Lake Ontario outflows. These outflows would not be as high as some which occurred in the period 1973-1976. However, Lake Ontario would still exceed its maximum target level of 246.8 feet. Additional costs for excavation and control works would appear to be required to satisfy all criteria and other requirements for the current regulation of Lake Ontario. The modified channel could be adequate to handle the increased inflow to Lake Ontario resulting from limited Lake Erie regulation. The locations of excavations required in the St. Lawrence River are shown in Figure 2.

6. Evaluation of Regulation Plans

The economic evaluation estimates the dollar value of benefits and losses under the proposed plans for a 50-year project period. The water supply sequence for the period 1900-1976 was used to evaluate the performance of the regulation plans. These supplies were also applied to the projected 50-year conditions to compute the projected benefits or losses to each interest in both countries for each lake.

Table 2 shows the effects of Lake Erie regulation on the major economic interests of the Great Lakes. All the effects together with the costs of the Niagara regulatory works, have been converted to present worth in order to compare project feasibility.

As expected, limited Lake Erie regulation would bring about some benefits to the coastal zone and recreational beach interests. This is because of the reduction in the flood and erosion damages, and the increase in beach area as a result of lowering lake levels. At the same time, however, losses to commercial navigation and recreational boating would occur because of the reduced depth. There would also be net losses to hydro-electric power. This is because some of the additional water would be available in the Niagara River at high supply conditions when it can neither be used nor stored for future use. Hence, this additional water would go over the Niagara Falls and, once gone, it would not be recoverable for hydro power generation at the Niagara projects. The net result is that, under regulation, less water would be available for hydro power generation under low water supply conditions.

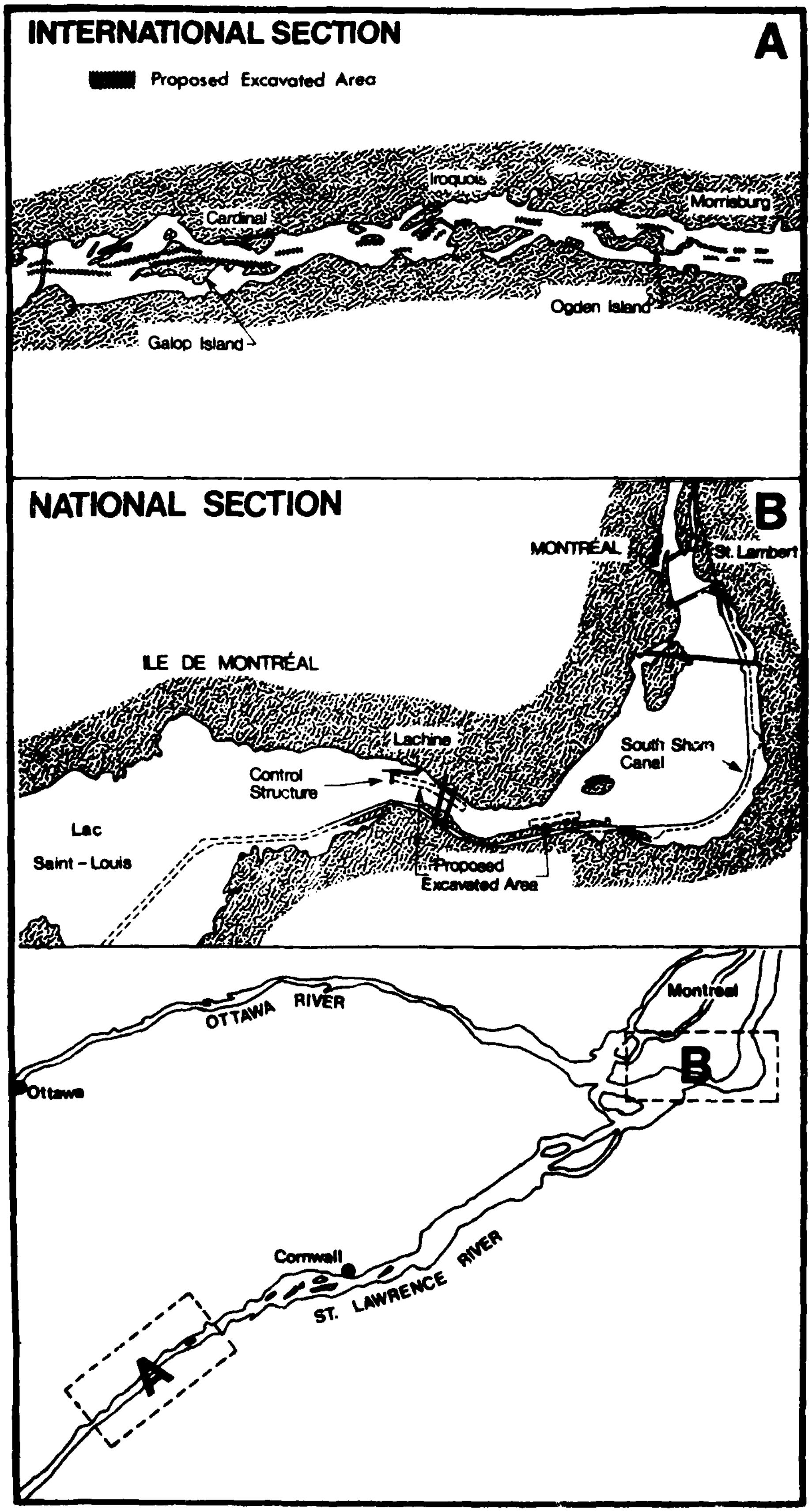


FIGURE 2: Proposed Excavated Areas

Table 2 Preliminary Economic Analysis Summary

COST OF NIAGARA REGULATORY WORKS		BLACK ROCK LOCK (4,000cfs)	SQUAW ISLAND DIVERSION (10,000 cfs)	NIAGARA RIVER STRUCTURE (25,000 cfs)
First Cost ($ millions)		$10.3	$ 19.6	$111.4
O & M Cost ($ millions)		$ 1.6	$ 2.0	$ 3.9
TOTAL ($ millions)		$11.9	$ 21.6	$115.3

Benefits (Losses) in millions of dollars, converted to present value.

Shore Property	-U.S.	$ 9.0	$23.2	$ 51.3
	-Canada	$ 1.9	$ 4.0	$ 6.8
	TOTAL	$10.9	$27.2	$ 58.1
Beaches	-U.S.	$ 5.1	$15.6	$ 38.6
	-Canada	$ 1.8	$ 4.8	$ 12.6
	TOTAL	$ 6.9	$20.4	$ 51.2
Boating	-U.S.	($5.2)	($10.8)	($ 34.5)
	-Canada	(*)	(*)	(*)
Navigation	-U.S.			
	-Canada			
	TOTAL	($13.3)	($39.5)	($121.7)
Hydro Power	-U.S.	($ 4.5)	($ 2.6)	($ .9)
	-Canada	($16.4)	($16.0)	($ 9.8)
	TOTAL	($20.9)	($18.6)	($ 10.7)
TOTAL BENEFIT (LOSS)		($21.6)	($21.3)	($ 57.6)

* Comparable study for Canadian recreational boating evaluation was not carried out in this study, but losses would be of the same order of magnitude as that of the U.S. Boating.

It is anticipated that lake level changes due to regulation would result in detrimental impacts on wetland-dependent wildlife on Lakes Erie and St. Clair due to changes and losses in wetland vegetation. Also, fish would experience a decrease in habitat and wetland-produced food. Effects on Lake Ontario wetlands and associated wildlife are expected to be indeterminable or slightly beneficial. Overall, water quality throughout the lower Great Lakes and the St. Lawrence River would not be significantly affected by limited Lake Erie regulation. It is anticipated that the construction and operation of any of the Niagara regulatory works could have adverse effects on the local environment. The nature and magnitude of these effects depend on the particular works and their locations.

7. Preliminary Findings

1. By means of excavations and control works in the Buffalo, New York-Fort Erie, Ontario area, it would be possible to lower the maximum water levels of Lake Erie. There would also be a lowering of its mean and minimum levels and the lowering effects would be transmitted to the upper Great Lakes. The costs of the works necessary to achieve Lake Erie lowering are high and tend to increase rapidly as the amount of lowering increases.

2. There would be economic benefits to coastal zone and recreational beach interests. However, these are offset by losses to commercial navigation, recreational boating and to hydropower interests. The resulting net benefit would be negative based on the information available to the Board.

3. The lowering of Lake Erie is achieved by increasing its outflow and while this could be done without increasing the maximum level of Lake Ontario, it would require an increase in the frequency and duration of high Lake Ontario outflows. These flows would not be as high as some which occurred in the period 1973-1976, but Lake Ontario would still exceed its maximum target level of 246.8 feet. Additional costs for excavations and control works would appear to be required to satisfy all the criteria and other requirements for the current regulation of Lake Ontario. The modified channel could be adquate to handle the increased inflow to Lake Ontario resulting from limited regulation of Lake Erie.

4. Since environmental impacts are generally negative, there are few environmental benefits that might be used to offset quantified economic losses in justifying further project consideration at this time.

NCBED-PW 11 February 1981

MEMORANDUM FOR RECORD

SUBJECT: Western Lake Erie Shore Field Trip, 21 January through 23 January 1981

1. Participants:

R. Mammoser
A. Fulco

2. Purpose: Familiarization with study area, take photos, determine if further study is required.

3. Sand Beach: Visited the Sand Beach area this trip. Noted types of dwellings - several expensive homes, but most wood frame. Counted number of dwellings and estimated value of properties. Measured difference in survey nails in poles along road and road surface. Estimated first floor elevations at +1.5 feet ± above road. Noted that many property owners had installed makeshift protection around houses. Some types were concrete walls, timber walls, and stone riprap.

Interviewed Mrs. Verb, year-round resident of Sand Beach. She lives on land side (south) of main road, Division Street. She indicated that they had not sustained any damage recently and stated that about 14-16 dwellings were lost in 1972 and 1973. Since then, the conservancy district has built levees along the ends of the road, where elevations are lowest. This prevents water from entering marsh lands to rear (south) of properties and thus prevents worse damages which occur when water returns to the lake. In addition, she said that any new buildings must be constructed at elevation of 580.0 on lakefront and 578.0 away from lake.

Marion and John Sinkey, officers of the conservancy district, were contacted. They are summer residents of Sand Beach. They stated that in 1980 only four or five houses sustained any damages, which were from the lake side, and these were not severe. Every major storm affects someone, although the damage is spotty. Major damage comes from the northeast, although unless this direction is maintained for 3 days, damage is only minimal.

Hydraulics will take the information gathered and see if any type of project can be justified. It is the opinion of this writer that because of the limited number of dwellings and extent of damages that no project can be justified.

4. Long Beach - Visited this area which is just west of Sand Beach. This area contains approximately 126 dwellings and on the average the buildings are desirable and relatively nice, as well as expensive. Spoke to one

EXHIBIT 69

resident who indicated that the Long Beach area has not sustained extensive damages, and that Sand Beach and Locust Point have more serious problems.

Resident stated that the worst condition experienced within last 10 years was water above first floor level at about 1 inch. Last year (1980) in May, water rose to 1 foot above road, but receded quickly and little damage occurred.

No further action is suggested at Long Beach.

5. Locust Point: This area is adjacent to Long Beach on the west side. The dwellings here are poor, crowded, and number about 135 in total. A marina and canal are at the extreme west end of development. No estimate of damages or elevations was obtained. Further study might be advisable at this area.

6. Washington Township: This area extends along Summitt Road from the Ottawa River crossing to the Michigan-Ohio border, on the east side of Summitt. Twenty-one nice, expensive (100 K+) homes are involved. Most are back from the river a considerable distance (in excess of 100 feet). Some homes have protective walls along the river and several first floor elevations are 9-10 feet above level of river.

One property owner was interviewed. He indicated that they had not had a problem because they are away from river a considerable distance. He said that there were three homes adjacent to the State line that sit closer to the river that may have experienced damages.

No further action is recommended at Washington Township because of the limited number of dwellings and damages.

7. Other Areas: Visited lake areas at Howard Farms, Remo Beach, and Oregon, as well as inland area at Bono. Purpose of visit was familiarization. Several photos were taken.

DISPOSITION FORM

For use of this form, see AR 340-15, the proponent agency is TAGCEN.

REFERENCE OR OFFICE SYMBOL	SUBJECT
NCBCO-TO	Survey Information Requested for Bono, OH, etc.

XXX THRU: C-O ~~Div.~~ Brz

TO: Engr. Div.
Attn: NCBED-PW

FROM Toledo Projects Office DATE 18 Feb 81 CMT 1
McCARTHY/skf/#667

1. Attached is information requested per 28 Jan 81 DF and subsequent request of Al Fulco. Information pertains to Bono, Locust Point, Sand Beach and Long Beach.

2. For Bono a community layout is attached. Addresses, type of structure, etc., are shown. We estimated 70 houses at $17,000 ea (no contents included) = $1,190,000 plus 7 businesses worth $300,000 (no contents included) for a total of $1,500,000. From talking with local people these values are high if anything.

3. The elevation of the water in Ward Canal was 570.5 last week. The lowest point on Rt. 2 (separates Ward Canal from Bono) is 576.4. There has never been flooding due to lake effects and it became even less likely about 10 years ago when Rt. 2 was raised. Any local flooding has been from the interior and this was essentially taken care of when a pump was installed about 10 years ago at Rt. 2 and Main St.

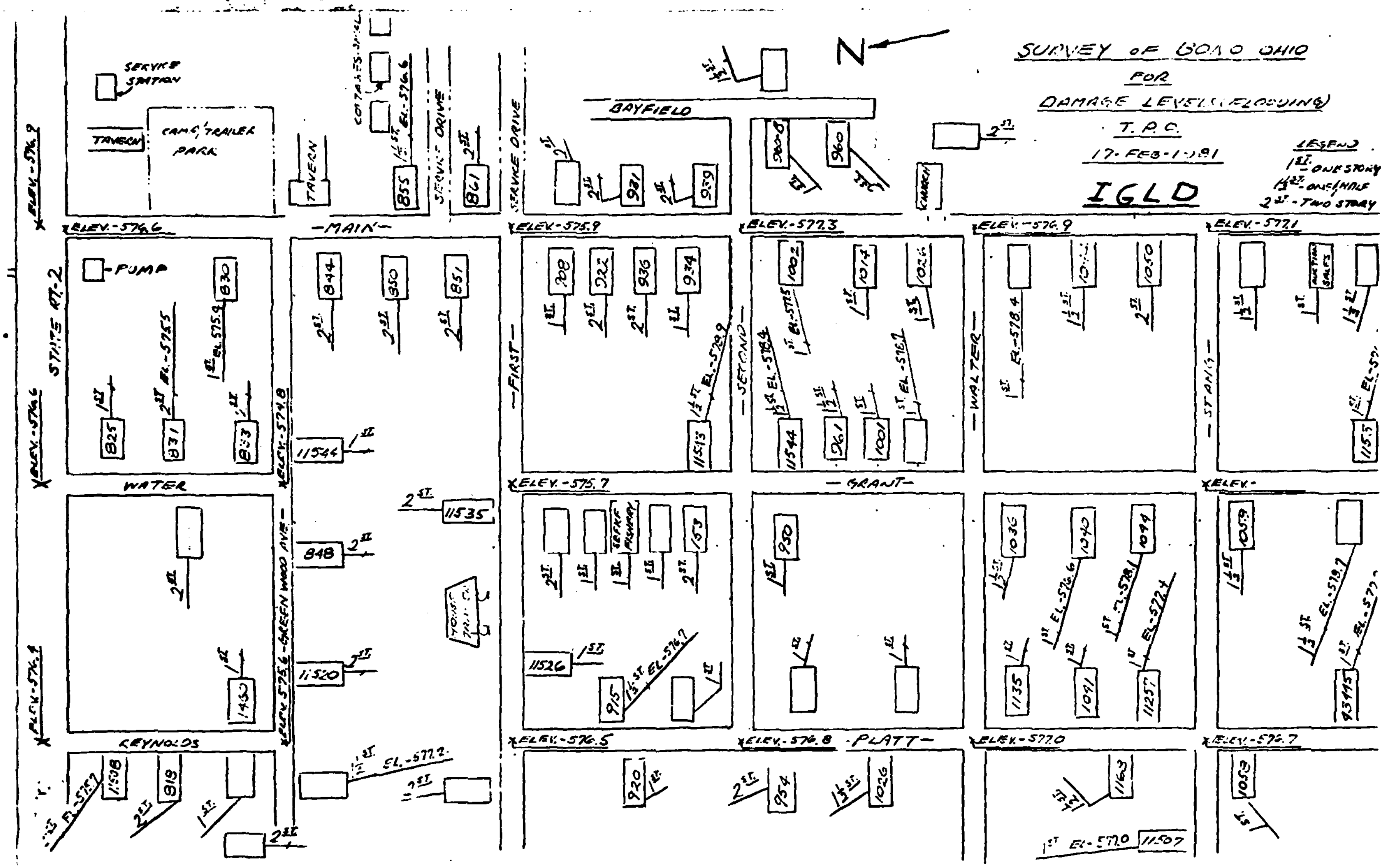
4. Your homemade maps for Sand Beach, etc. were slightly distorted so you may want to check addresses to be sure we are talking about the same house. Survey notes available upon request.

John A McCarthy
JOHN A. McCARTHY
Chief, Toledo Projects Office

Incls

EXHIBIT G10

DA FORM 1 FEB 67 2496 REPLACES DD FORM 96, WHICH IS OBSOLETE.


SURVEY OF BONO OHIO
FOR
DAMAGE LEVELS (FLOODING)
T.P.C.
17-FEB-1981
IGLD
LEGEND
1ST - ONE STORY
1½ST - ONE & HALF
2ST - TWO STORY
N
BAYFIELD
STATE RT-2
MAIN
FIRST
SECOND
WALTER
STANG
WATER
GRANT
REYNOLDS
PLATT
GREEN WOOD AVE
SERVICE DRIVE
SERVICE STATION
TAVERN
CAMP, TRAILER PARK
PUMP
CHURCH
COTTAGES
ELEV.-576.6
ELEV.-575.9
ELEV.-577.3
ELEV.-577.1
ELEV.-575.7
ELEV.-576.5
ELEV.-576.8
ELEV.-577.0
ELEV.-576.7
ELEV.-574.8

APPENDIX H

CORRESPONDENCE

COUNTY OF LUCAS
OFFICE OF COUNTY ENGINEER
435 MICHIGAN STREET
TOLEDO, OHIO 43624

GEORGE F. WILSON, P.E.
LUCAS COUNTY ENGINEER
Phone 259-8620

JOHN H. CRANDALL, P.E.
CHIEF DEPUTY
Phone 259-8606

February 6, 1979

Corp of Engineers
Buffalo District
1776 Niagara Street
Buffalo, New York, 14207

Attn: James De La Plante

Re: Lucas County Shore Flooding and Erosion Problems

Gentlemen:

We would like to thank you for the opportunity you gave our office and the communities and public agencies in Lucas County to meet with you on January 10, 1979 at the Jerusalem Township Hall. We were not able to stay for your complete program and, therefore, were unable to give you a list of the problem areas we are aware of in the County. We are, therefore, taking this opportunity to bring these to your attention. The following areas and comments are located on the enclosed map for reference.

1) Shoreland Road area flooding: Flooding has occurred along Shoreland Road east of Summit Street in the past due to high water in the lake. This area is still not protected. This flooding was minor in comparison to Reno Beach, Howard Farms flooding, however.

2) Flooding City of Oregon: Flooding along the lake in Oregon has occurred. This area is still not protected.

3) Little Cedar Point: This area has been protected by dikes, however, maintenance of both the lake front and secondary dikes must be scheduled on a continuing basis.

4) Oregon Water Intake: Access to this could be lost during periods of high water in that the access road is below flood elevations.

5) Reno Beach: Temporary dikes should be maintained on a continuing basis and should be upgraded to "permanent status" for flood insurance purposes.

EXHIBIT H-1

6) Howard Farms: Temporary dikes should be maintained. Erosion is occurring along the east side of this conservancy district dike. These dikes are considered temporary and should be upgraded for flood insurance purposes.

7) Metzger Marsh: (State owned wildlife area) This is being lost to the lake.

8) Maumee River Flooding: Ice jams cause flooding in the River Valley at several locations.

9) Anchor Point Marina: The Board of Lucas County Commissioners have received complaints from the owners of this privately owned Marina that the penisula separating the Marina and Coolie Canal Boat Launching Area from Reno side cut is eroding and creating a potential security problem for the Marina.

Very truly yours,

George F. Wilson

George F. Wilson, P.E.
Lucas County Engineer

JCW/saw

Enclosure

CATAWBA TOWNSHIP TRUSTEES

3624 N. W. CATAWBA ROAD
PORT CLINTON, OHIO 43452

DOROTHY GULAU, Clerk

February 6, 1979

Department of the Army
Buffalo District Corps of Engineers
1776 Niagara Street
Buffalo, New York 14207

Attention: Mr. James DelaPlante

Gentlemen:

Thank you for the opportunity to meet with you on 11 January in relation to your "Ohio Western Lake Erie Shore Beach Erosion and Flood Damage Study".

This letter is to review and record the information we attempted to contribute in your meeting as follows:

1. Nearly all of the Township's shoreline is privately owned and privately used; thus qualifys only as Category V in your chart, page 12 of the meeting handout material. All these lands are of very high value, are held as small parcels, and the owners can well undertake the construction of any protection needed; many already have.

2. The exceptions to the above generalization are located as on the marked map attached and we would comment as follows:

   A is the site of the Corp's West Harbor Natural Channel Project. We have already favorably endorsed this Corp project. We believe the Corp has completed a "cost benefit analysis" on this project, consequently, no additional comment is warranted.

   B is the site of the Gem Beach West Harbor Channel which is currently being improved, funded by the State and private interests.

   C is approximately 200 feet of frontage on the lake of the right of way for State Highway 53. This is a gravel beach which has been stable throughout the 50 years that we have known it.

   D is approximately 900 feet of frontage owned for siteing the dock for ferry service to the Islands. Same is mostly outcropped limestone at or near the waterline and has shown very little damage by erosion in the 50 years that we have known it.

   E is approximately 400 feet of frontage of the State of Ohio owned Catawba State Park is gravel beach, and is stable.

EXHIBIT H-2

Department of the Army
Buffalo District Corps of Engineers

F is the location of the "Rock Ledge" segment of Sand Road's erosion project recently completed by the Corp.

There is approximately seven miles of Lake Erie Shoreline in Catawba Island Township and the above factors suggest that there is not much possibility of any qualified project in Catawba Island Township.

Very truly yours,

CATAWBA ISLAND TOWNSHIP TRUSTEES

Paul H. Rofkar

Paul H. Rofkar

Francis M. Burkart

William A. Fritz

PHR:djg

OFFICE OF
OTTAWA COUNTY ENGINEER
COURTHOUSE
PORT CLINTON, OHIO 43452

JOHN G. PAPCUN, P.E.
COUNTY ENGINEER

(419) 734-3174
734-3175

February 16, 1979

Department of the Army
Buffalo District, Corps of Engineers
1776 Niagara Street
Buffalo, New York 14207

Attention: Daniel D. Ludwig, P. E., Colonel, Corps of Engineers

Re: Western Lake Erie Shore Study

Dear Colonel Ludwig:

Relative to your Orientation Workshops of January 10 and 11, 1979 and your letter of February 12, 1979, I offer the following comments.

After the 1972 and 1973 floods, the Corps studied many areas in our county for flood control projects. The only project that was feasible was in Bay Township and was built by your district. We realize it is difficult to achieve a benefit-cost ratio for flood control projects. However, we further believe benefit-cost ratios may be substantiated for jetty projects as shown on the enclosed map. A similar map was submitted to your office and the Detroit District in 1973.

The proposed jetties at creek or river outlets would be relatively inexpensive compared to the benefits derived such as reduced erosion, reduced wave damage, better drainage, increased protection for boaters during storms and expansion of inland boat marinas. Some of the jetties built during W.P.A. days have been neglected and are practically non-existent. We would at least like to see a benefit-cost ratio study made of the noted locations.

I would also like to know the status of the Black Rock Dam and lock proposal at Buffalo to help control the Lake Erie water levels. It would seem to me that the benefit-cost ratio of this project would make it the number one priority project on Lake Erie providing Canada would agree.

Thank you for the opportunity to make comments and for your continued cooperation.

Very truly yours,

John G. Papcun

John G. Papcun,
Ottawa County Engineer

JGP/jh

EXHIBIT H-3

NCBED-PH

28 February 1979

Mr. John G. Papcun
Ottawa County Engineer
Court House
Port Clinton, OH 43452

Dear Mr. Papcun:

Thank you for your letter of 16 February 1979, and the accompanying map identifying problem areas along the Ottawa County shoreline. The jetty projects you propose may or may not be a viable solution to beach erosion control or flood damage prevention measures which the Western Lake Erie Shore study authorization primarily addresses. I have referred the concerns outlined in your letter to my Study Manager, Mr. James H. DeLaPlante III, (716) 876-5454, Ext. 2294; and as this study progresses we will insure your suggestions are considered.

In addition, we would like to know if there are any other areas within the county of Ottawa or on the islands that are being or could be potentially threatened by flood inundation since area studies were performed during the Operation Foresight Program of 1972 and 1973.

Finally, the feasibility study to modify Lake Erie water levels is entitled, The Lake Erie Regulation Study. The feasibility report of this study will be completed in the Fall of 1979. Information relating to preliminary findings will be available, and a public hearing in Toledo will be held at that time.

If you have any particular questions regarding the Lake Erie Regulation Study, please feel free to contact me or my Project Manager for the Lake Erie Regulation Study, Mr. Anthony J. Eberhardt at (716) 876-5454, Ext. 2258.

1s/2294

NCBED-PW
Mr. John G. Papcun

Again, I thank you for your comments and your cooperation.

Sincerely yours,

DANIEL D. LUDWIG, PE
Colonel, Corps of Engineers
District Engineer

CF:
NCBED-PW
NCBRO

DeLaPlante____
Eberhardt____
Zorich____
Gilbert____
Hallock/
Liddell____
Braun____
Ludwig____

APPENDIX I

BIBLIOGRAPHY

APPENDIX I

BIBLIOGRAPHY

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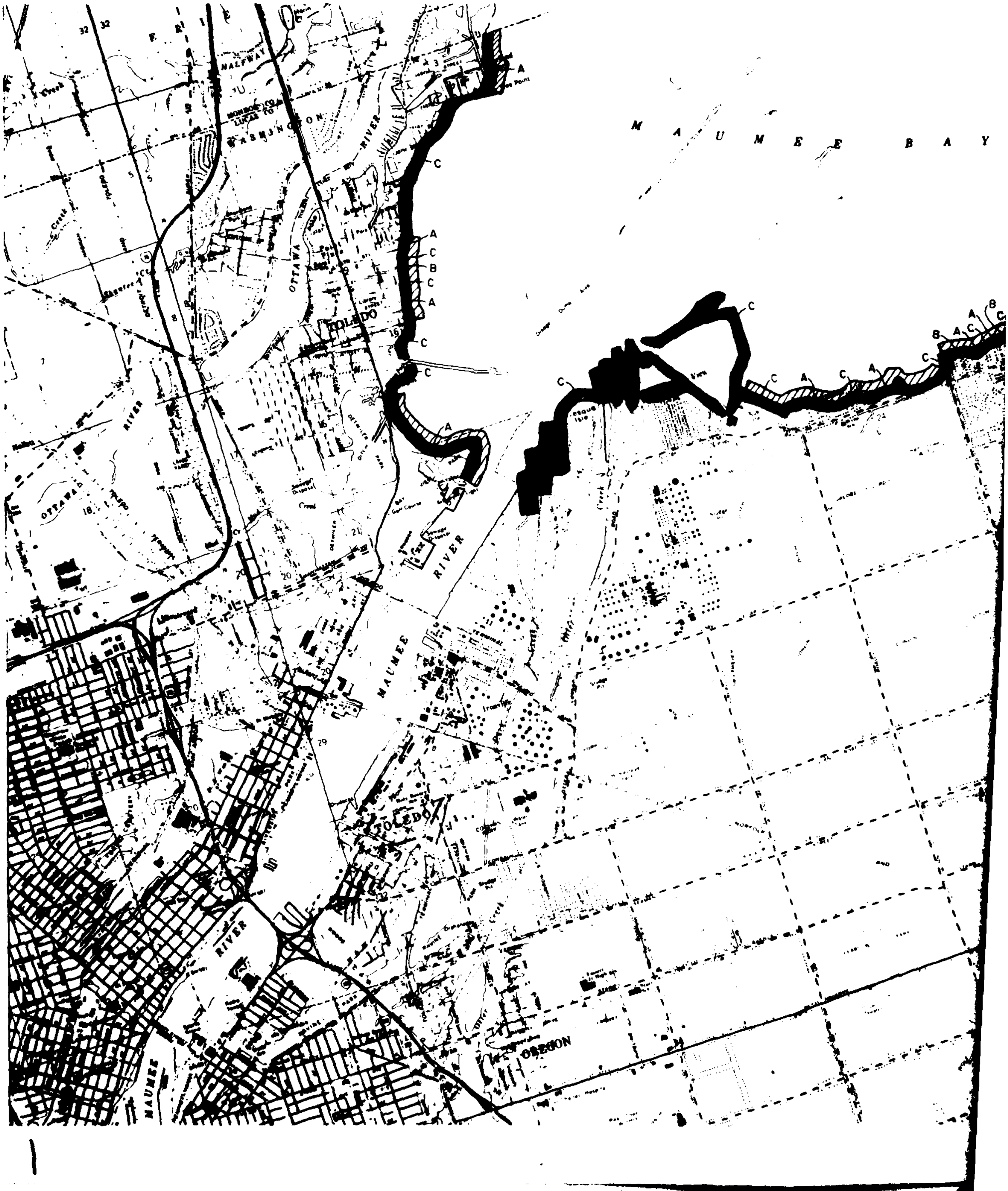
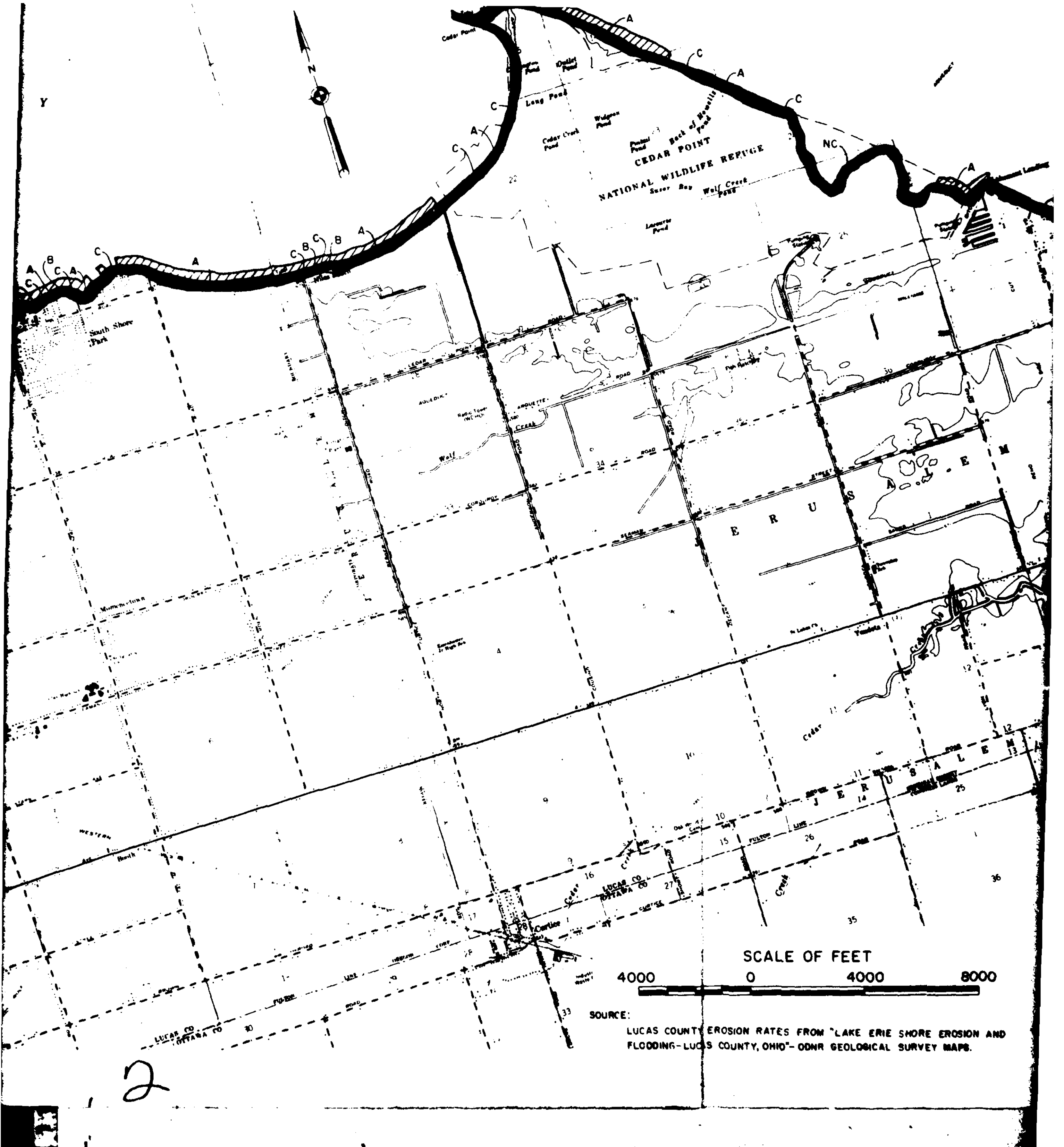
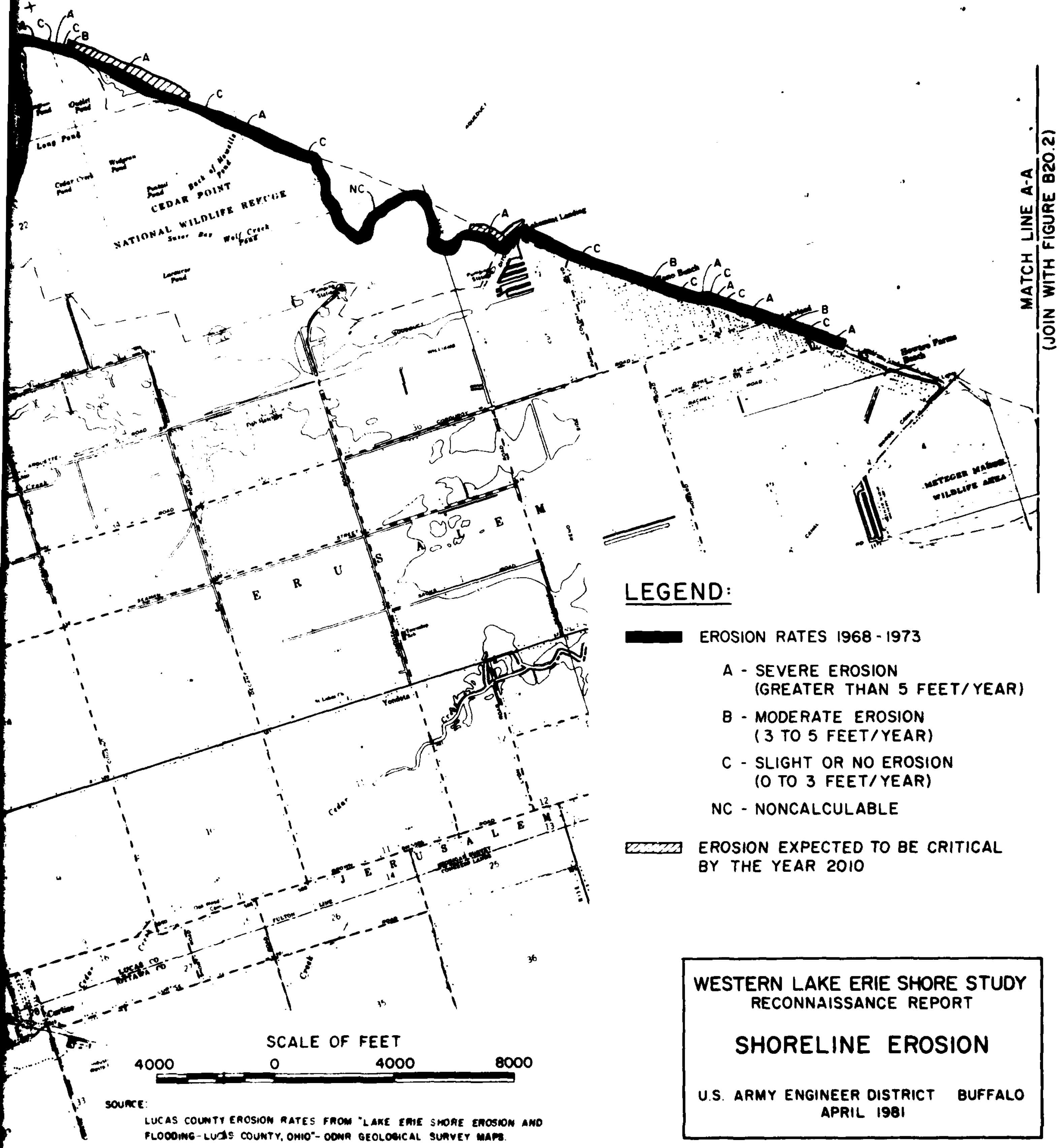

MAUMEE BAY
TOLEDO
OTTAWA RIVER
MAUMEE RIVER
OREGON
WASHINGTON
HALFWAY
A
B
C


Cedar Point
Long Pond
CEDAR POINT
NATIONAL WILDLIFE REFUGE
South Shore Park
JERUSALEM
Curtice
LUCAS CO
OTTAWA CO
SCALE OF FEET
4000 0 4000 8000
SOURCE:
LUCAS COUNTY EROSION RATES FROM "LAKE ERIE SHORE EROSION AND FLOODING-LUCAS COUNTY, OHIO"- ODNR GEOLOGICAL SURVEY MAPS.

2

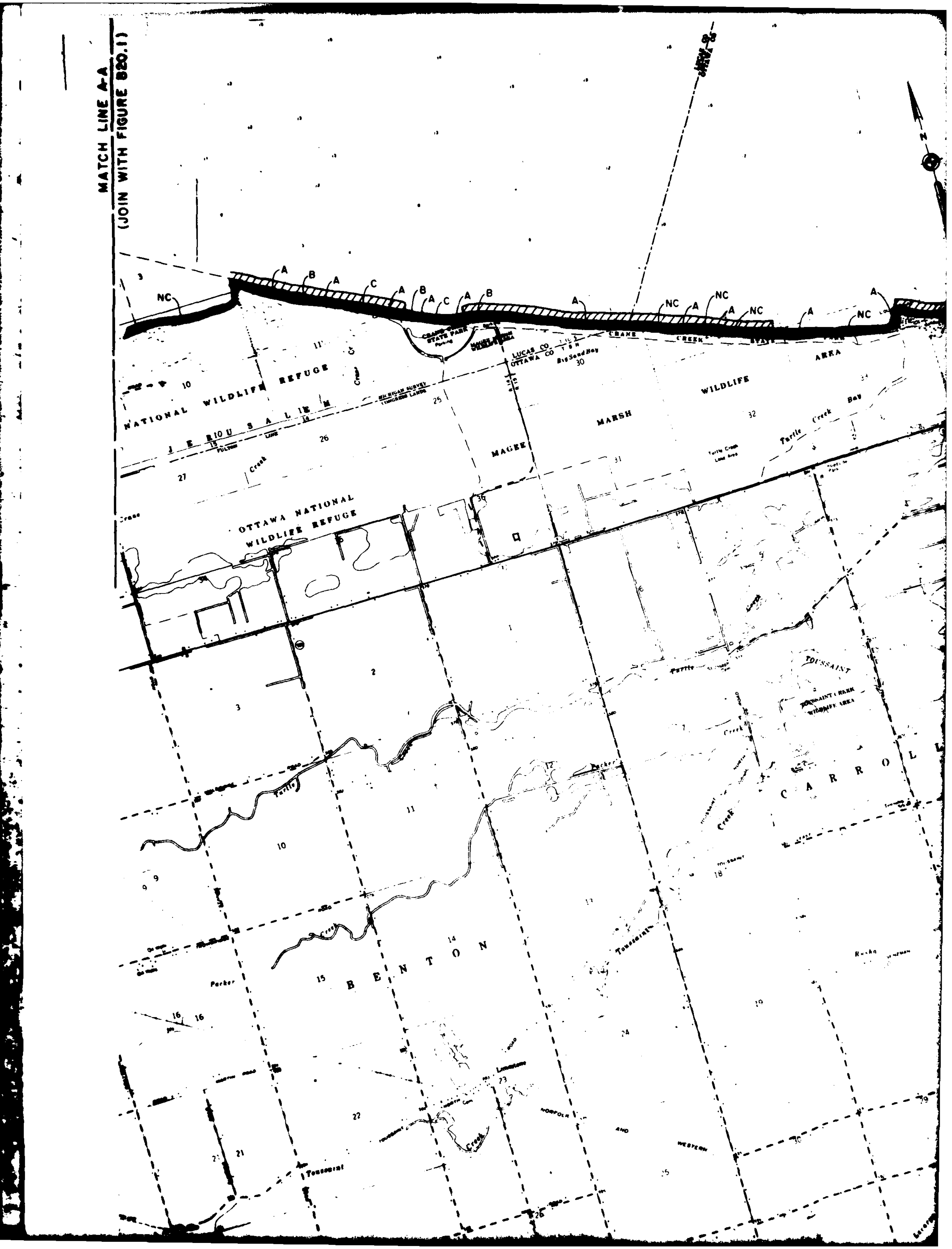


WESTERN LAKE ERIE SHORE STUDY
RECONNAISSANCE REPORT

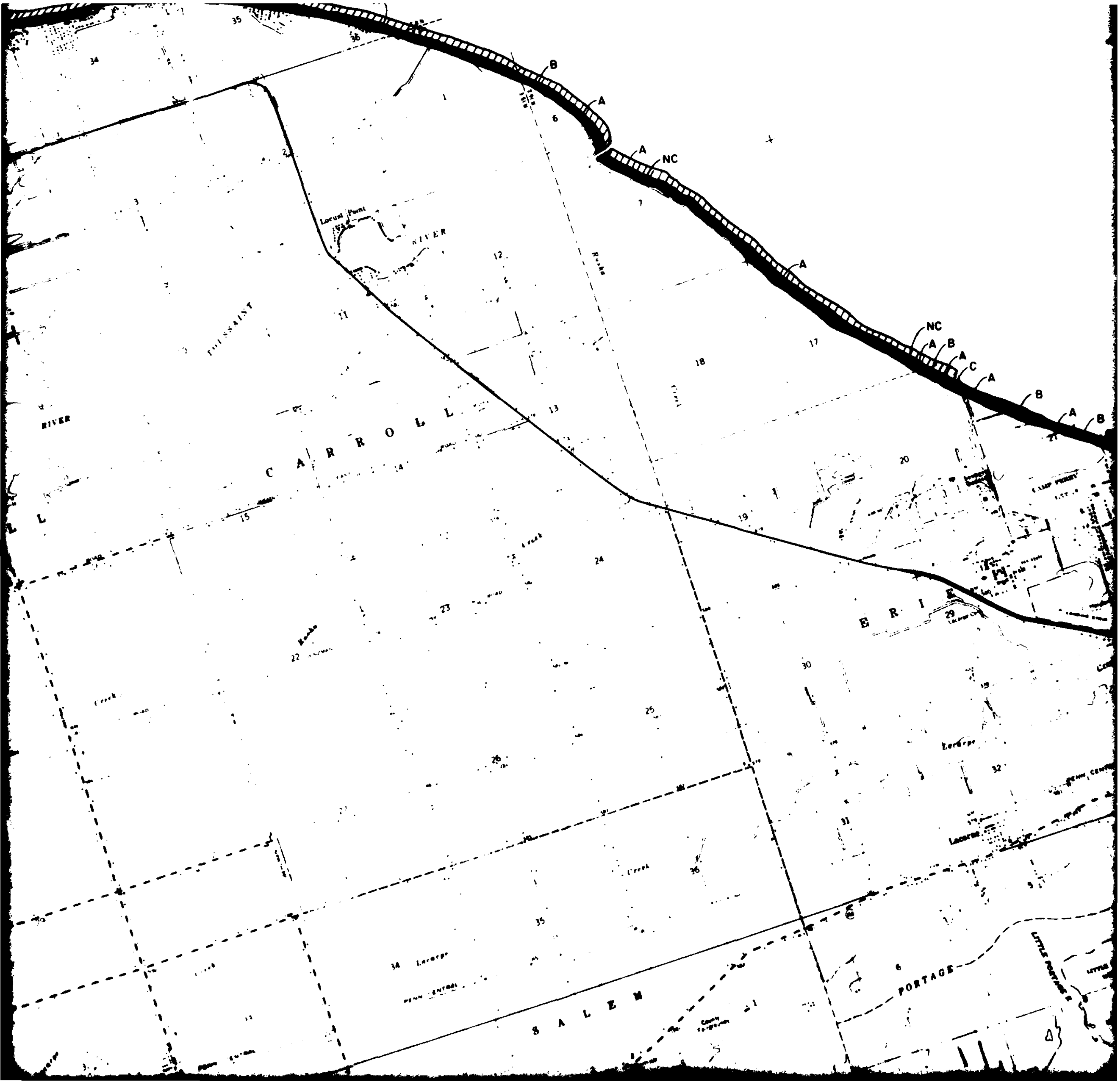
SHORELINE EROSION

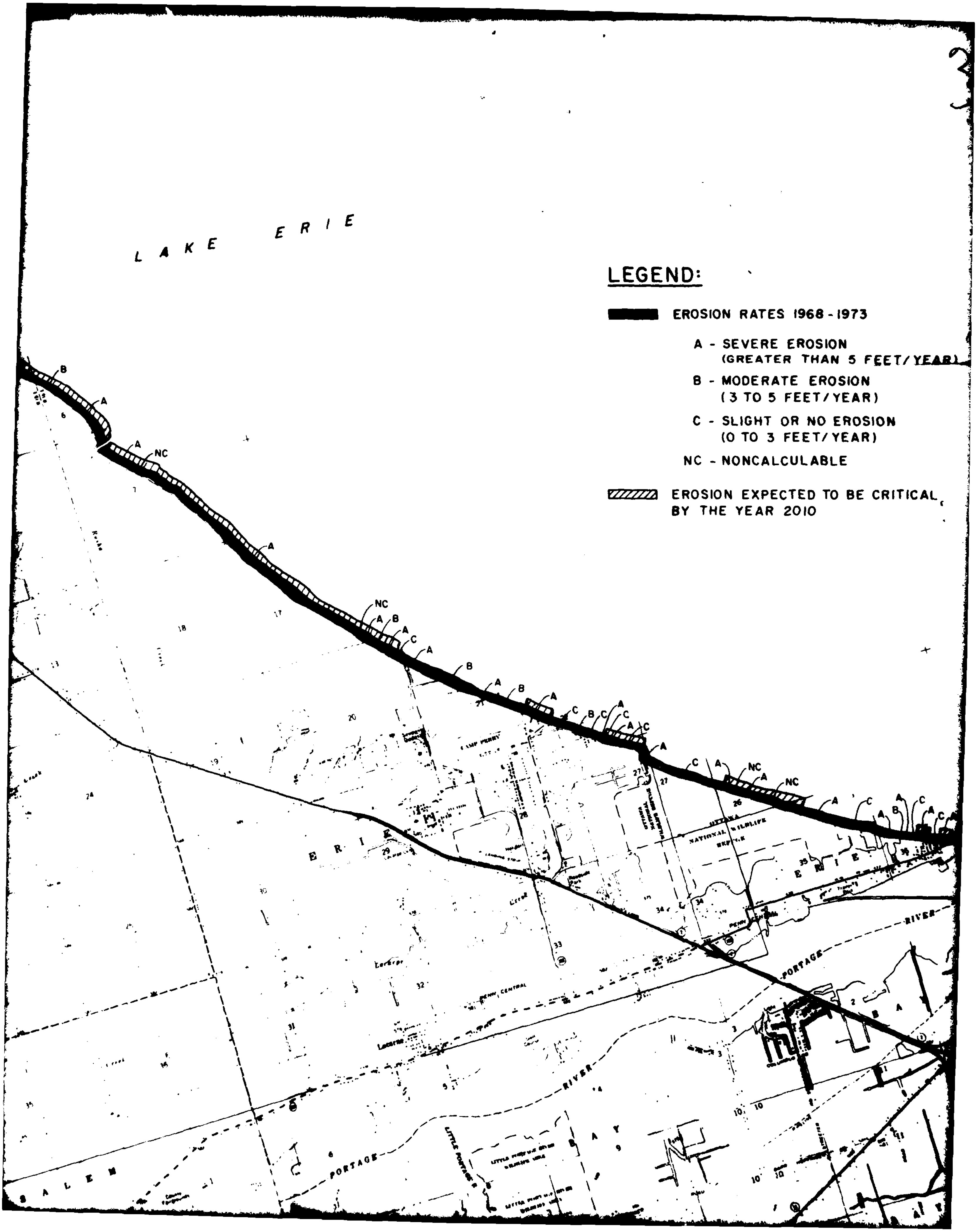
U.S. ARMY ENGINEER DISTRICT BUFFALO
APRIL 1981

FIGURE B20.1

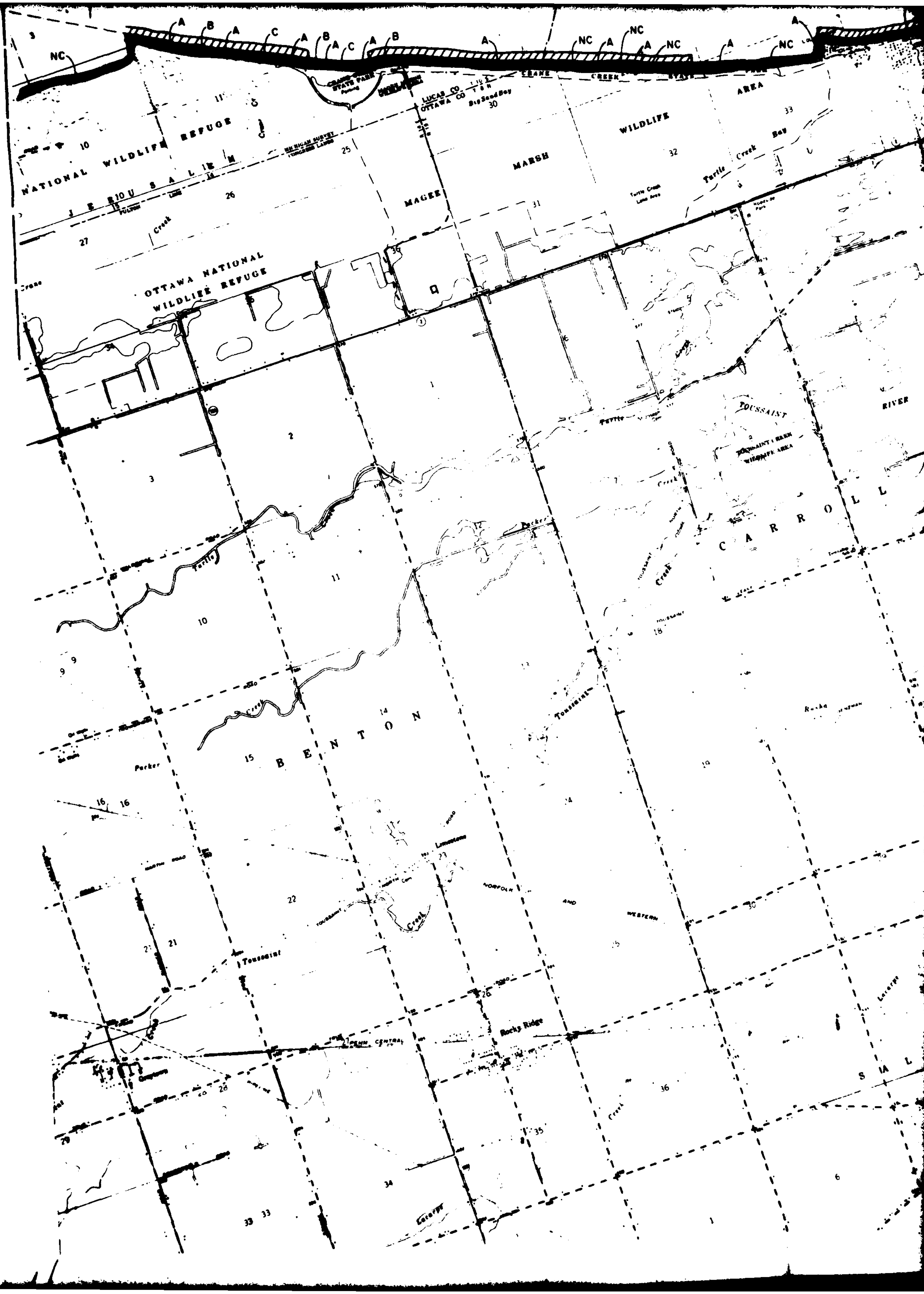


MATCH LINE A-A
(JOIN WITH FIGURE B20.11)
NATIONAL WILDLIFE REFUGE
JERUSALEM
OTTAWA NATIONAL WILDLIFE REFUGE
MAGEE MARSH WILDLIFE AREA
LUCAS CO
OTTAWA CO
TOUSSAINT CREEK WILDLIFE AREA
BENTON
CARROLL
Turtle Creek
Toussaint Creek
Crane Creek
NORFOLK AND WESTERN
N

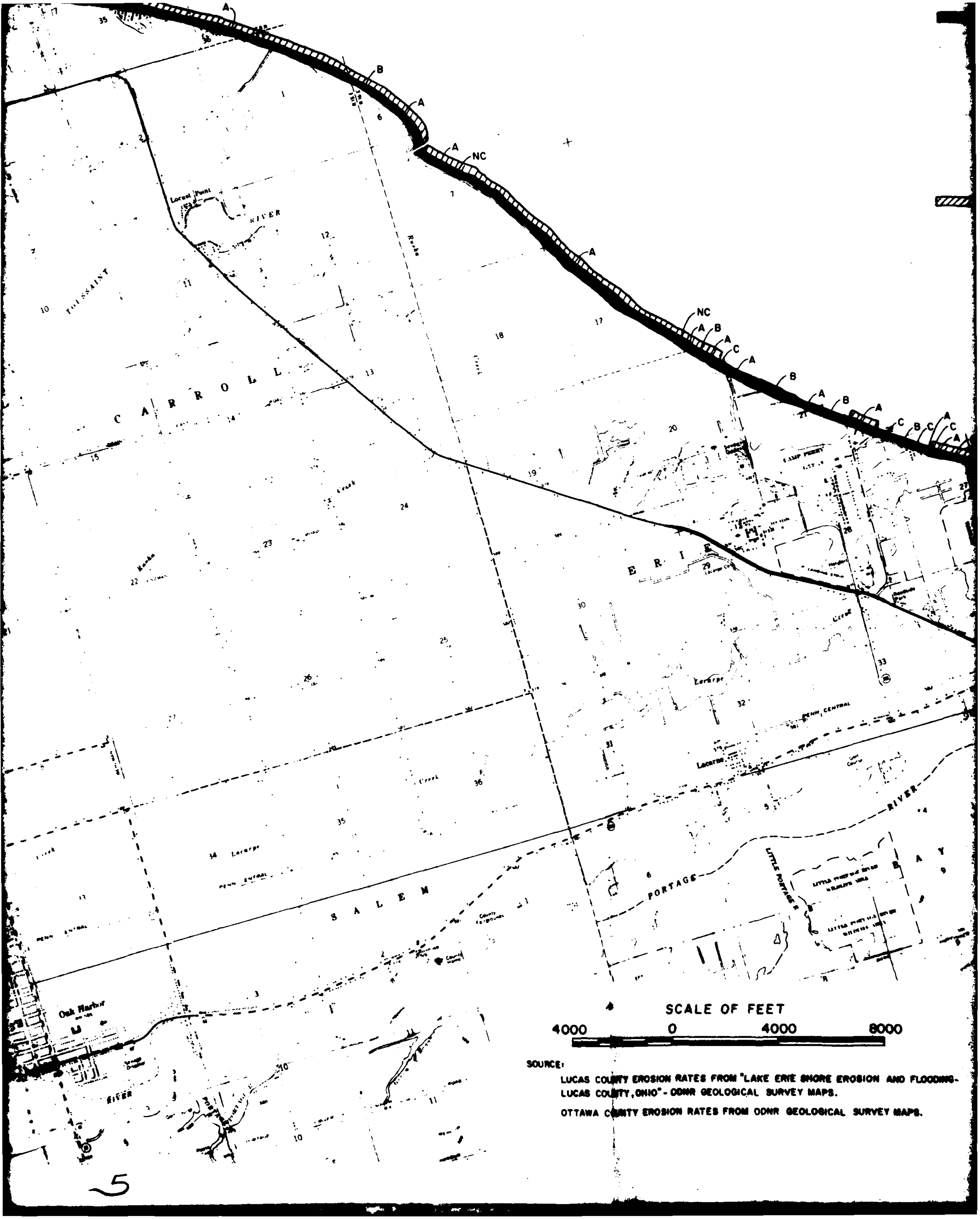

B
A
NC
C
Locust Point
RIVER
TOUSSAINT
C A R R O L L
E R I E
S A L E M
PORTAGE
CAMP PERRY
LITTLE PORTAGE R



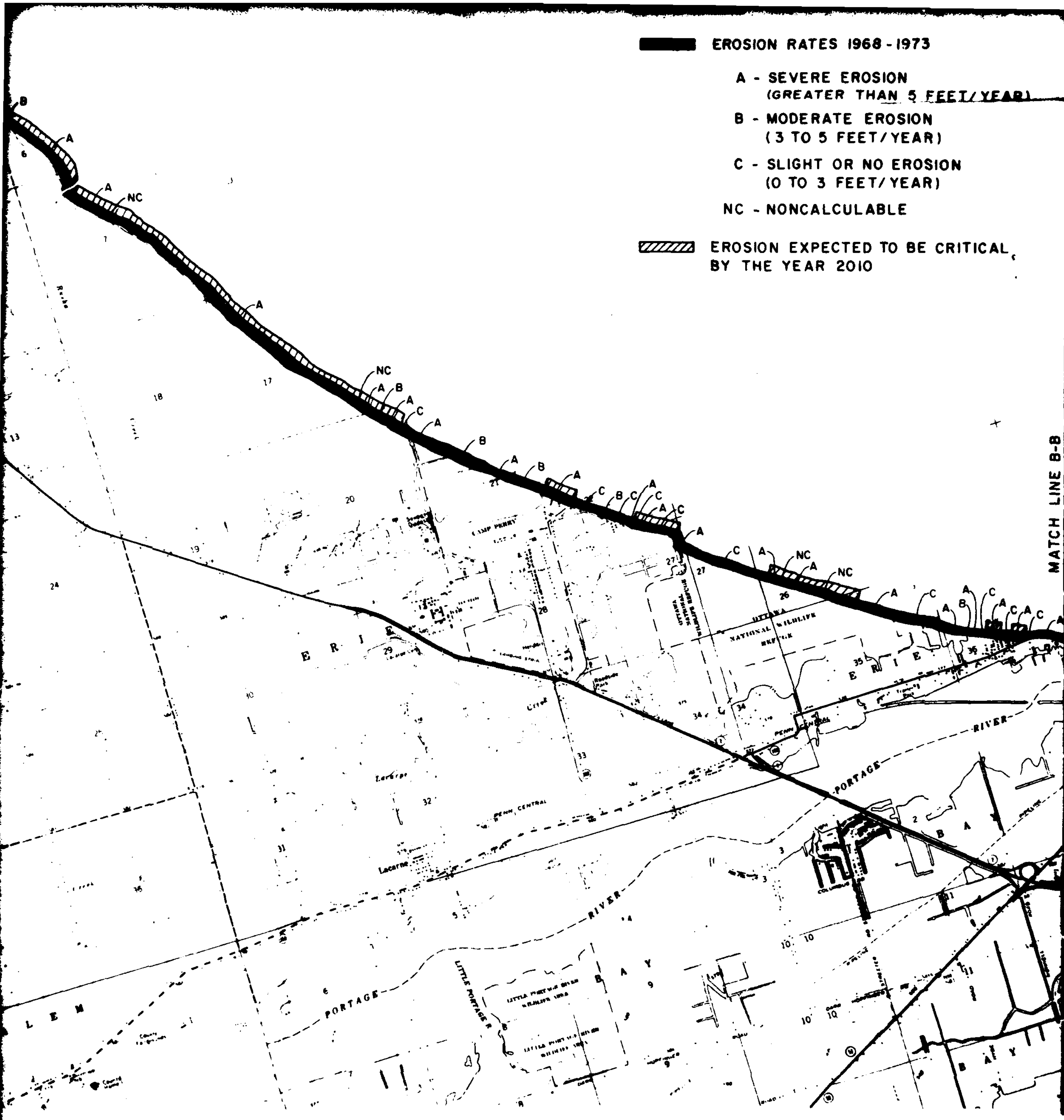
LAKE ERIE
LEGEND:
EROSION RATES 1968 - 1973
A - SEVERE EROSION (GREATER THAN 5 FEET/YEAR)
B - MODERATE EROSION (3 TO 5 FEET/YEAR)
C - SLIGHT OR NO EROSION (0 TO 3 FEET/YEAR)
NC - NONCALCULABLE
EROSION EXPECTED TO BE CRITICAL BY THE YEAR 2010
CAMP PERRY
OTTAWA NATIONAL WILDLIFE REFUGE
ERIE
PORTAGE RIVER
LITTLE PORTAGE
BAY
SALEM



NC
A
B
C
CRANE CREEK STATE PARK
LUCAS CO.
OTTAWA CO.
CRANE
CREEK
STATE
NATIONAL WILDLIFE REFUGE
JERUSALEM
MAGEE
MARSH
WILDLIFE
AREA
Turtle Creek Bay
OTTAWA NATIONAL WILDLIFE REFUGE
Crane
Creek
Turtle Creek
TOUSSAINT
RIVER
TOUSSAINT CREEK WILDLIFE AREA
CARROLL
Packer
BENTON
Toussaint Creek
Limestone
NORFOLK
AND
WESTERN
Tousssaint
Rocky Ridge
PENN CENTRAL
Lacarpe
SAL


CARROLL
ERIE
SALEM
TOUSSAINT
Locust Point
Camp Perry
Lacarne
Oak Harbor
PORTAGE RIVER
LITTLE PORTAGE R.
BAY
PENN CENTRAL
County Fairgrounds
A
B
NC
C
SCALE OF FEET
4000 0 4000 8000
SOURCE:
LUCAS COUNTY EROSION RATES FROM "LAKE ERIE SHORE EROSION AND FLOODING-LUCAS COUNTY, OHIO" - ODNR GEOLOGICAL SURVEY MAPS.
OTTAWA COUNTY EROSION RATES FROM ODNR GEOLOGICAL SURVEY MAPS.

5



SCALE OF FEET

4000 0 4000 8000

SOURCE:

LUCAS COUNTY EROSION RATES FROM "LAKE ERIE SHORE EROSION AND FLOODING-LUCAS COUNTY, OHIO" - ODNR GEOLOGICAL SURVEY MAPS.

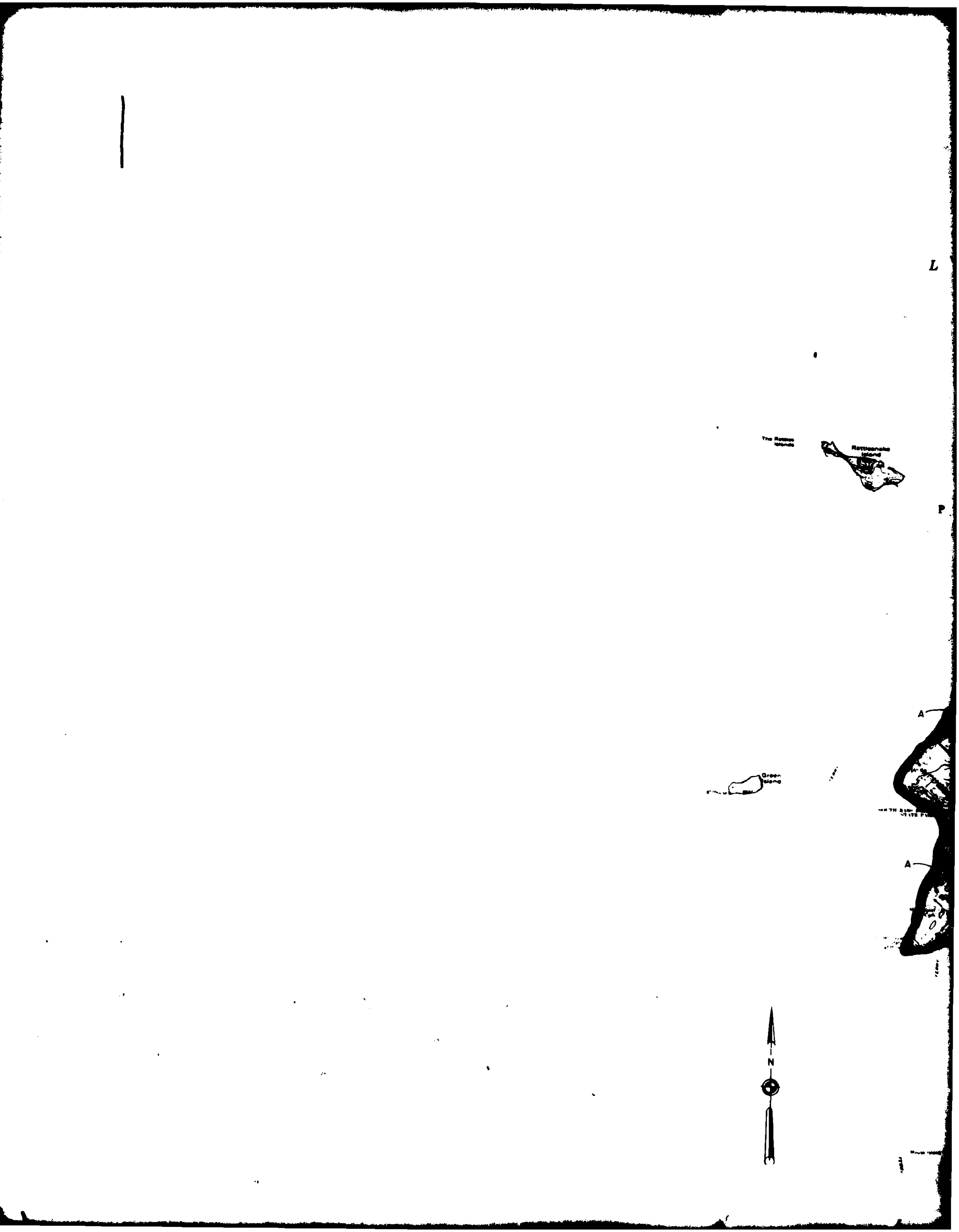
OTTAWA COUNTY EROSION RATES FROM ODNR GEOLOGICAL SURVEY MAPS.

WESTERN LAKE ERIE SHORE STUDY
RECONNAISSANCE REPORT

SHORELINE EROSION

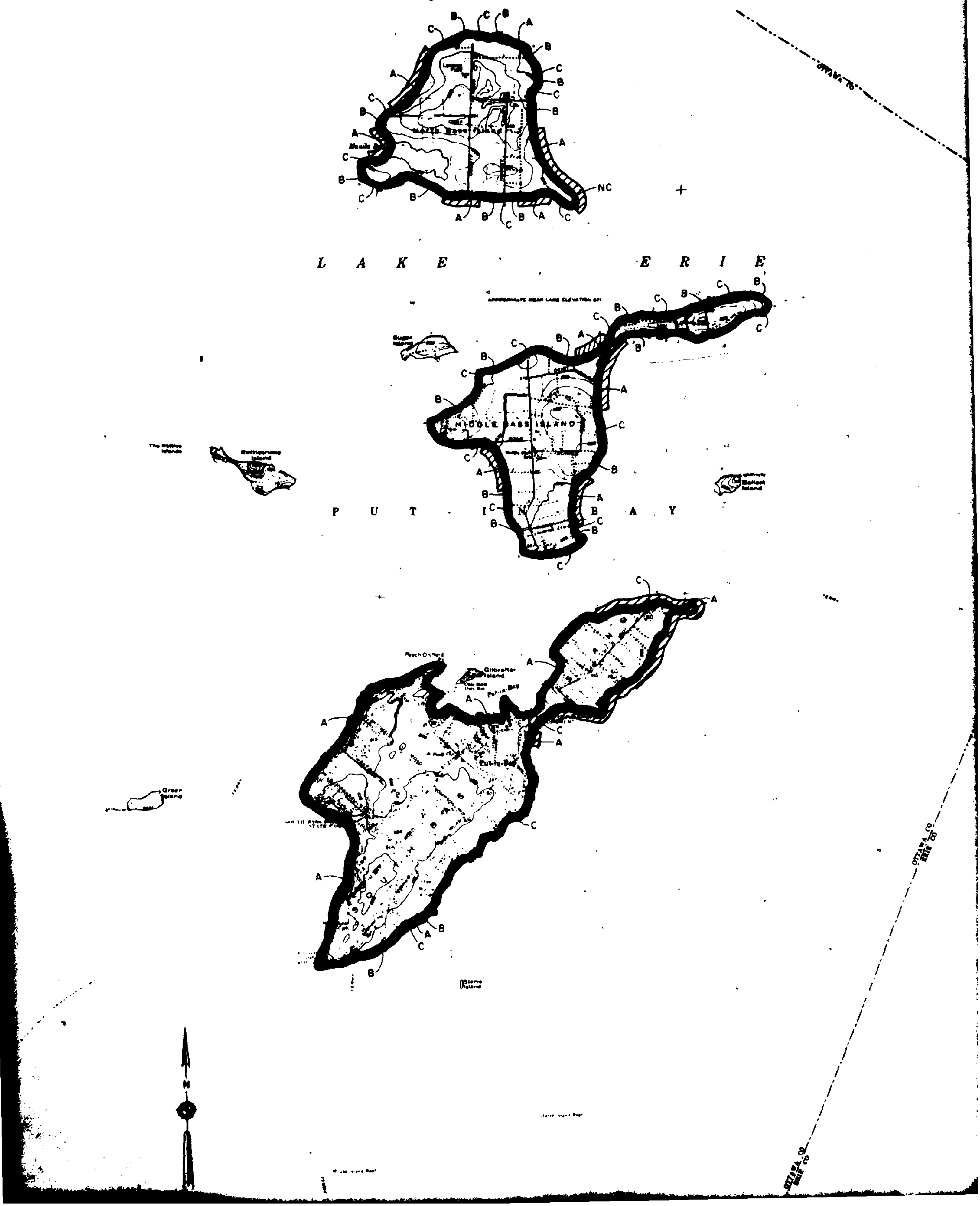
U.S. ARMY ENGINEER DISTRICT BUFFALO
APRIL 1981

FIGURE B20.2



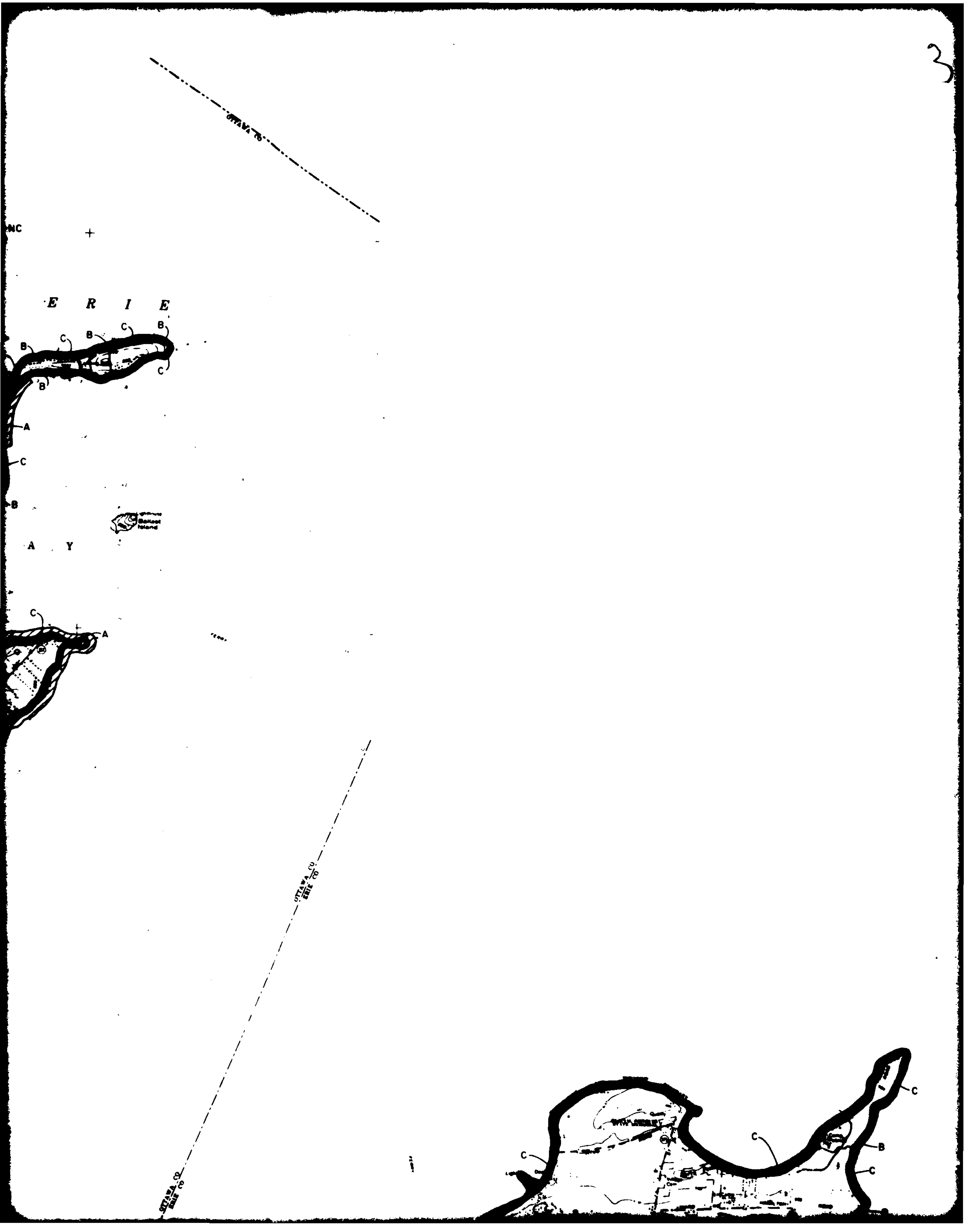
L
Rattlesnake Island
P
A
Green Island
A
N

12

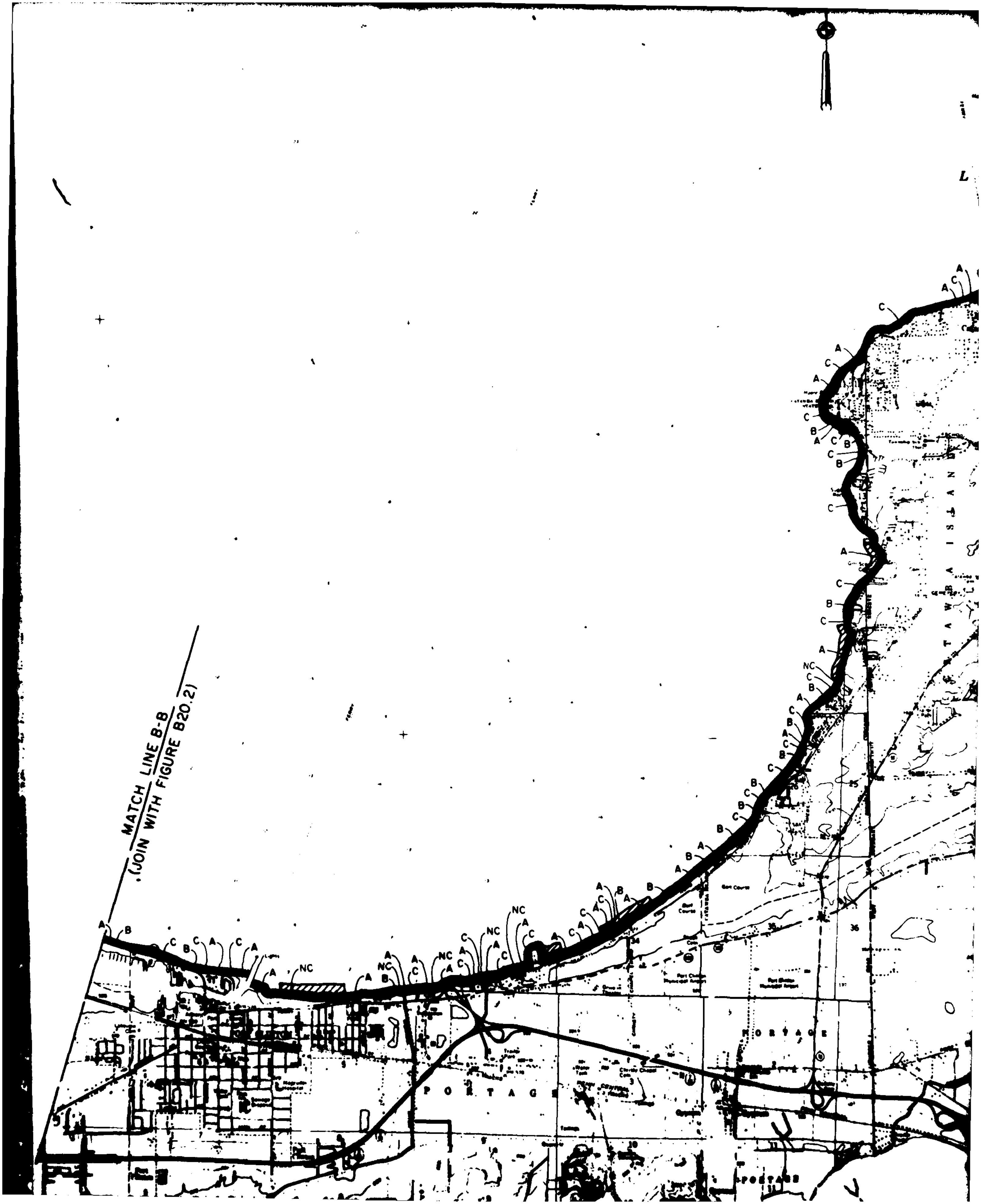


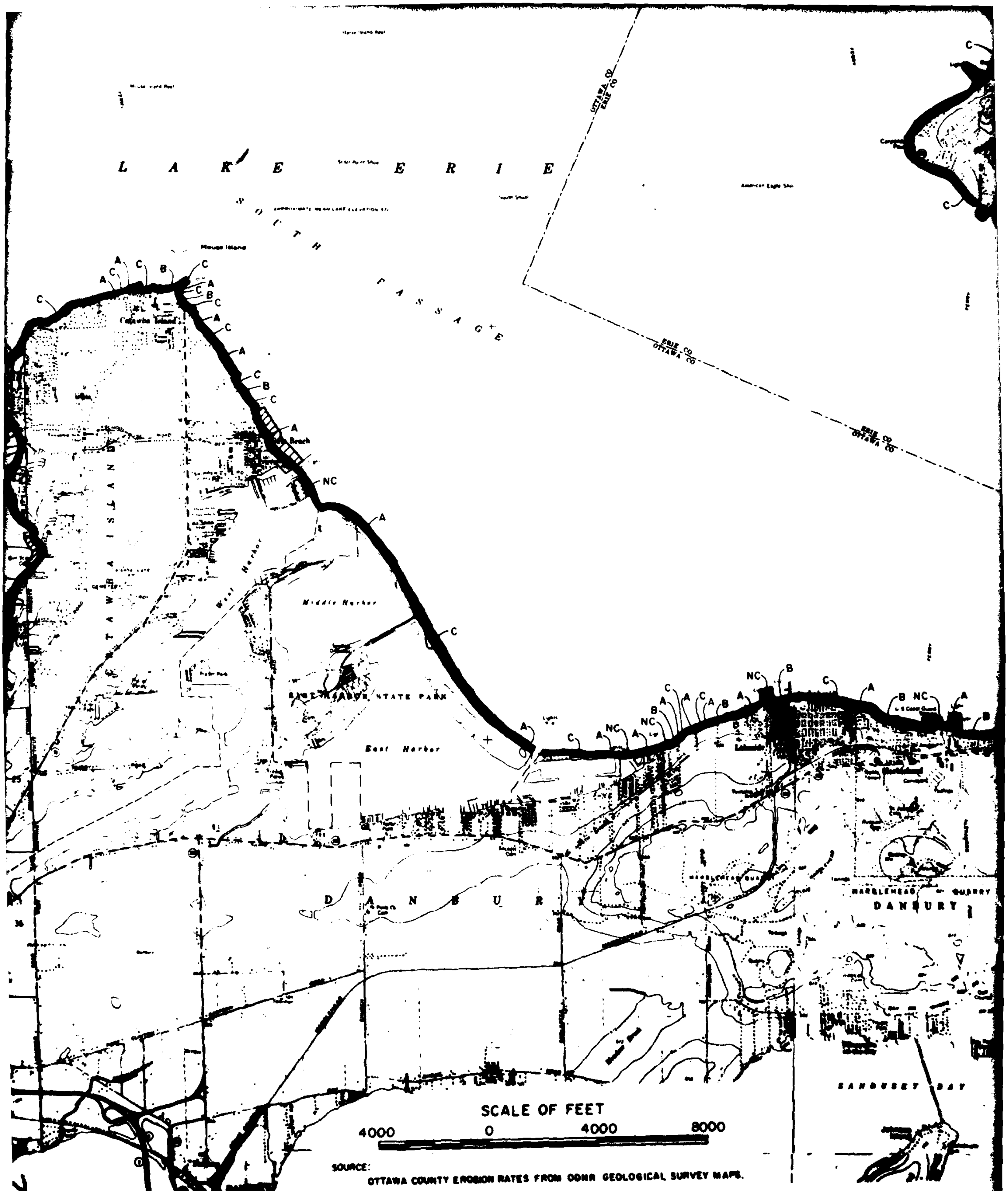
LAKE ERIE
PUT-IN-BAY
MIDDLE BASS ISLAND
Rattlesnake Island
Green Island
Gibraltar Island
Put-in-Bay
Peach Orchard
OTTAWA CO
ERIE CO
N

3

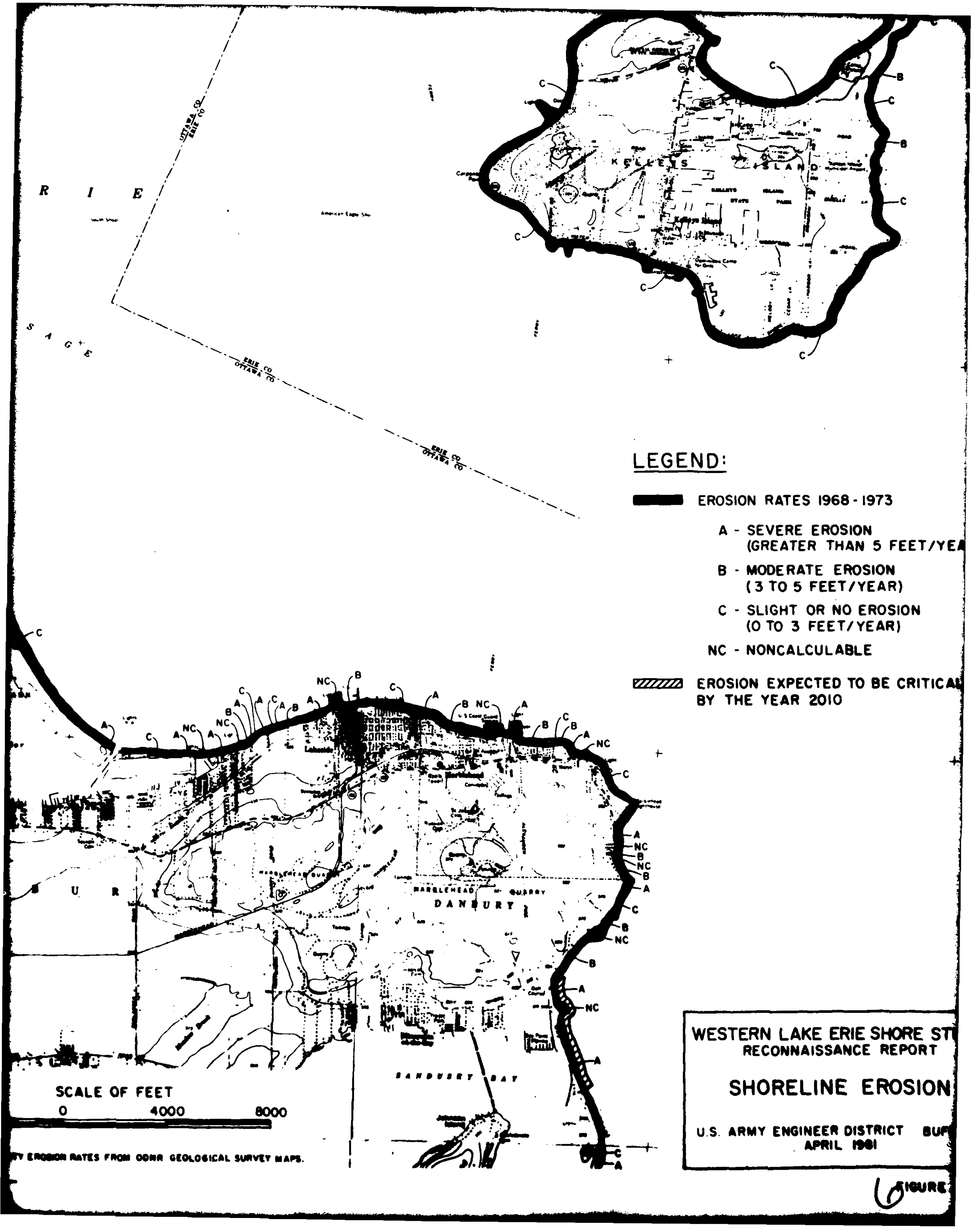


NC
E R I E
A Y
Ballast Island
OTTAWA CO
OTTAWA CO
ERIE CO
OTTAWA CO
ERIE CO

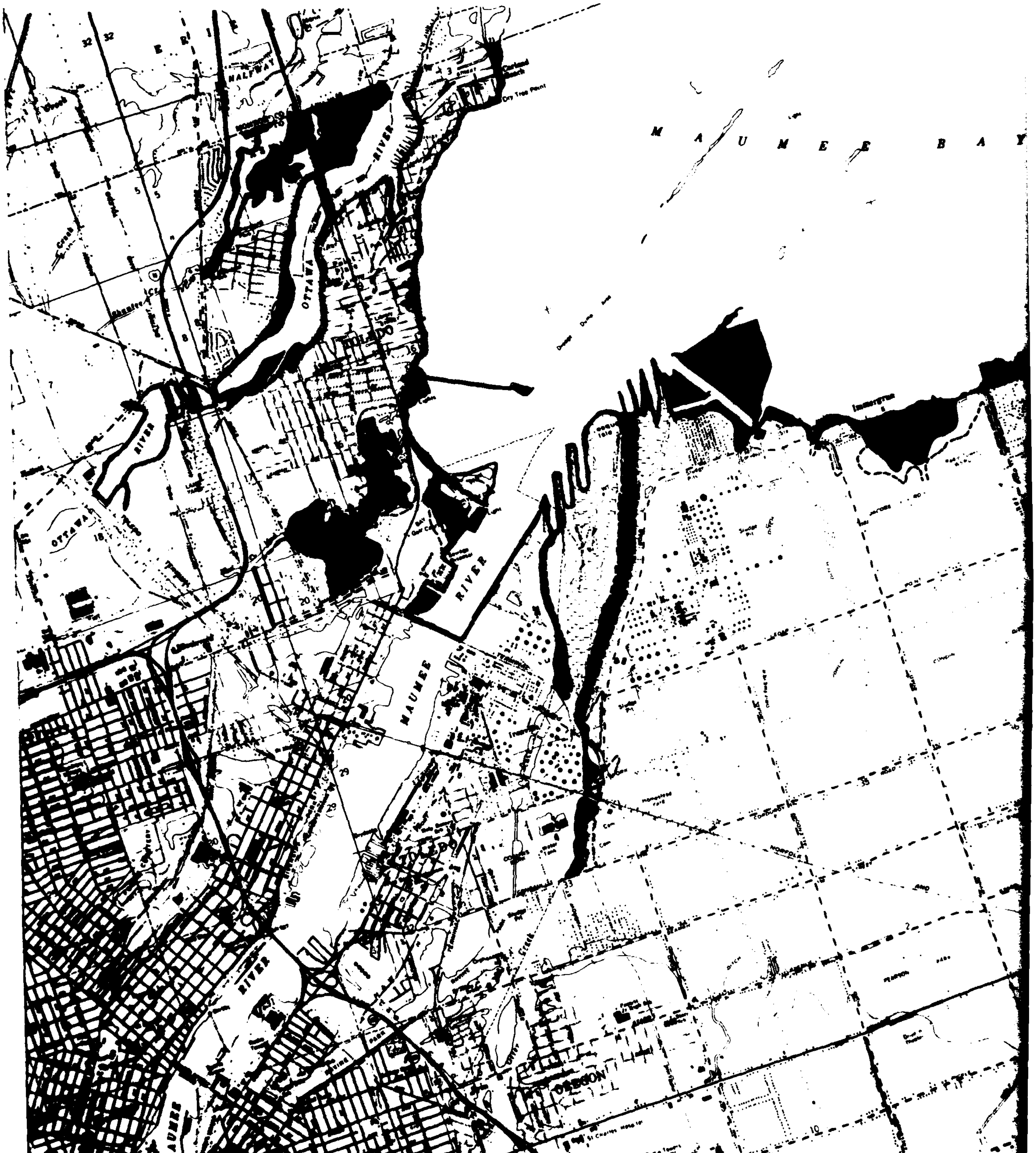

MATCH LINE B-B
(JOIN WITH FIGURE B20.2)
PORTAGE
PORTAGE
PORTAGE

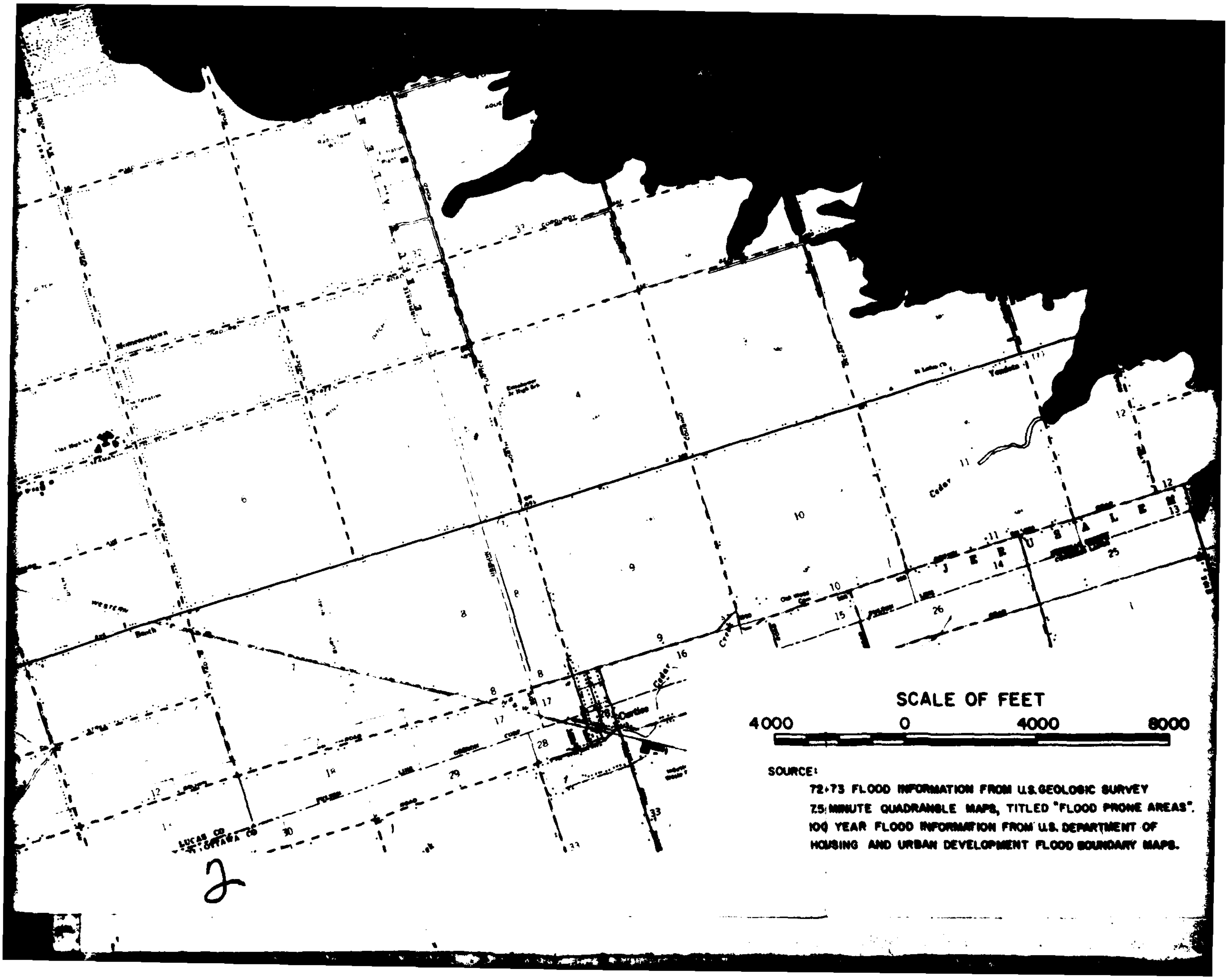

LAKE ERIE
SOUTH PASSAGE
Mouse Island
OTTAWA CO
ERIE CO
Middle Harbor
East Harbor
West Harbor
STATE PARK
DANBURY
MARBLEHEAD
QUARRY
SANDUSKY BAY
SCALE OF FEET
4000 0 4000 8000
SOURCE:
OTTAWA COUNTY EROSION RATES FROM ODNR GEOLOGICAL SURVEY MAPS.

5

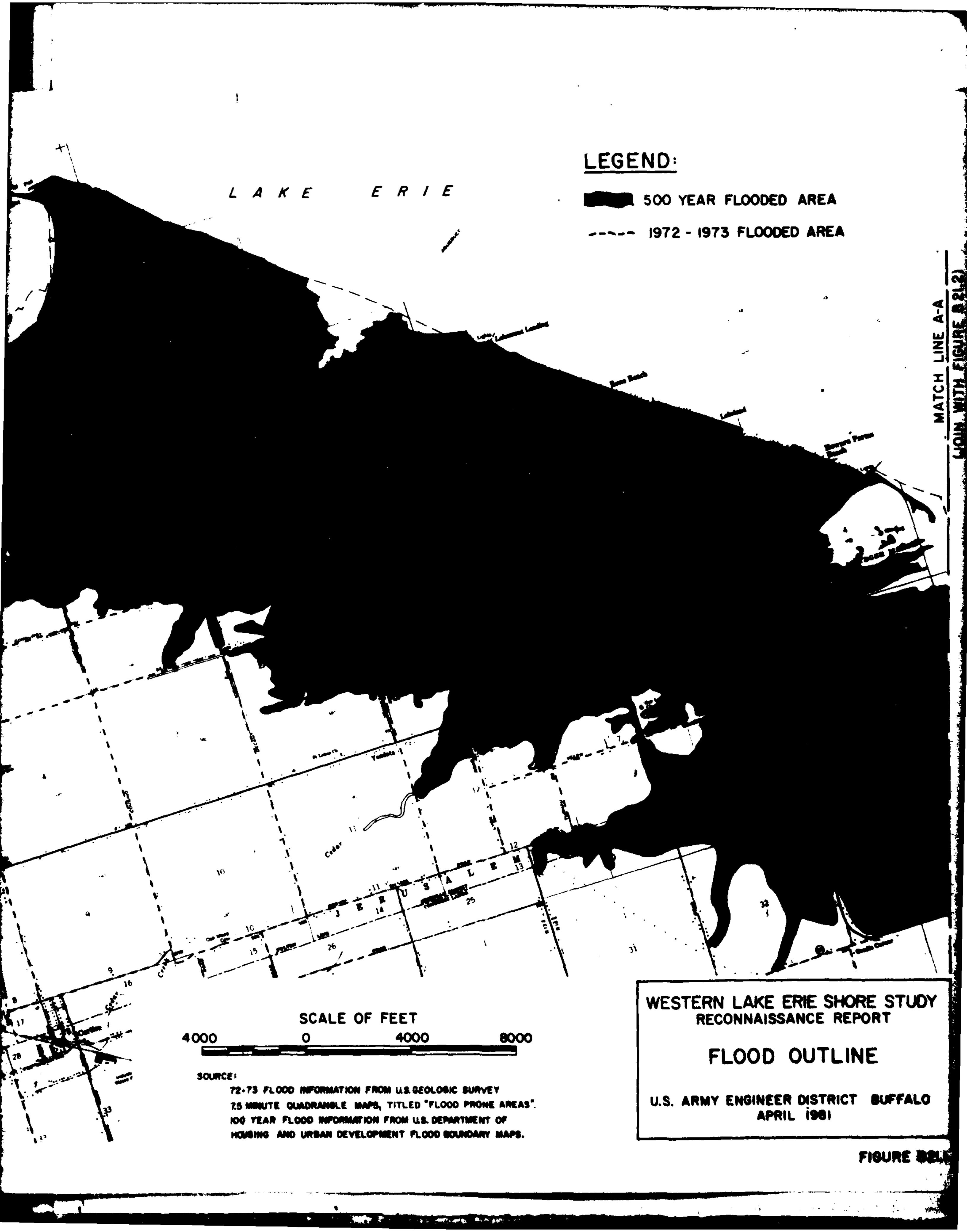


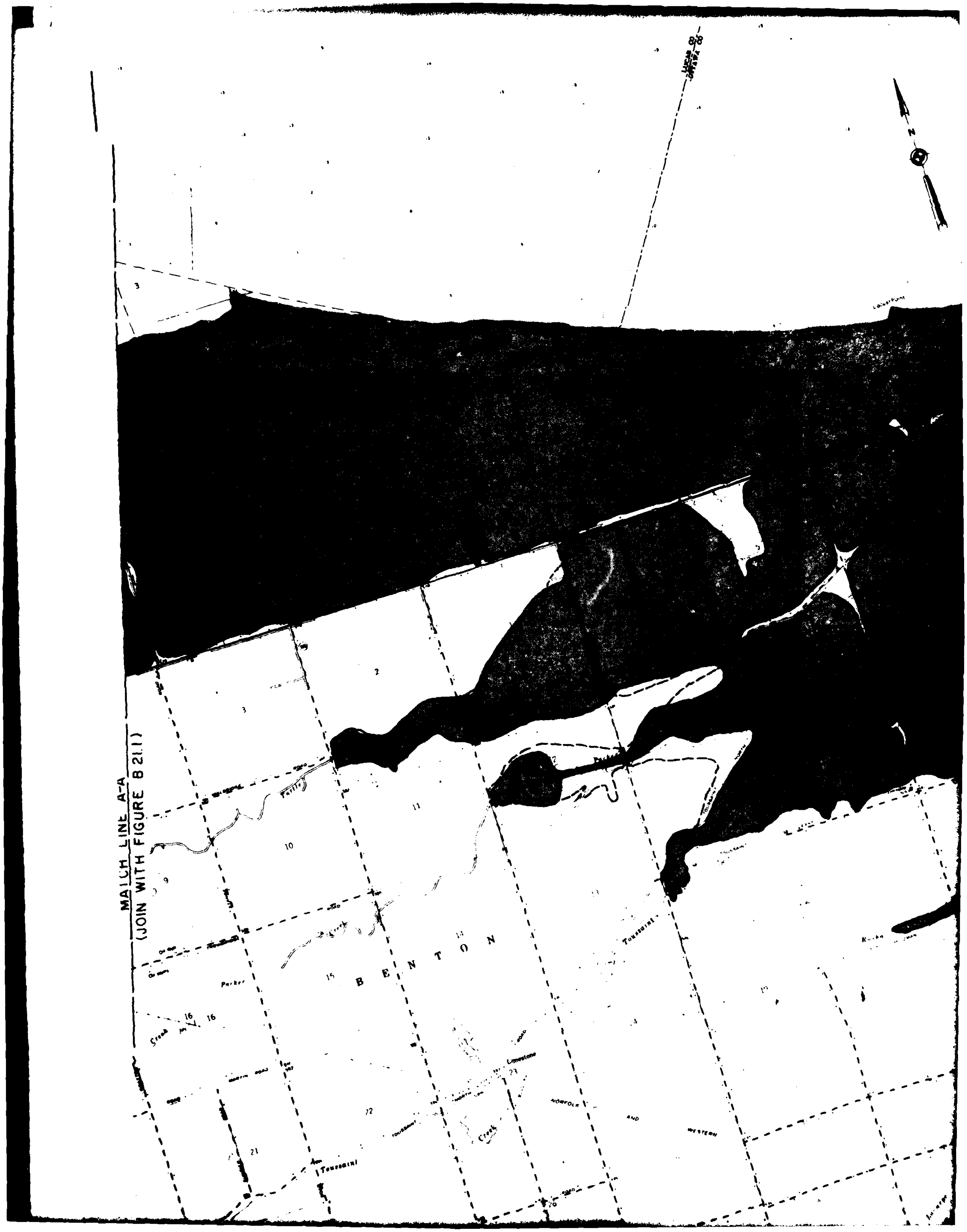
LEGEND:
EROSION RATES 1968 - 1973
A - SEVERE EROSION (GREATER THAN 5 FEET/YEA
B - MODERATE EROSION (3 TO 5 FEET/YEAR)
C - SLIGHT OR NO EROSION (0 TO 3 FEET/YEAR)
NC - NONCALCULABLE
EROSION EXPECTED TO BE CRITICAL BY THE YEAR 2010
KELLEYS ISLAND
ERIE CO
OTTAWA CO
DANBURY
MARBLEHEAD QUARRY
SANDUSKY BAY
SCALE OF FEET
0
4000
8000
Y EROSION RATES FROM ODNR GEOLOGICAL SURVEY MAPS.
WESTERN LAKE ERIE SHORE ST
RECONNAISSANCE REPORT
SHORELINE EROSION
U.S. ARMY ENGINEER DISTRICT BUF
APRIL 1981
6 FIGURE


M A U M E E   B A Y
OTTAWA RIVER
MAUMEE RIVER
TOLEDO
OREGON
HALFWAY



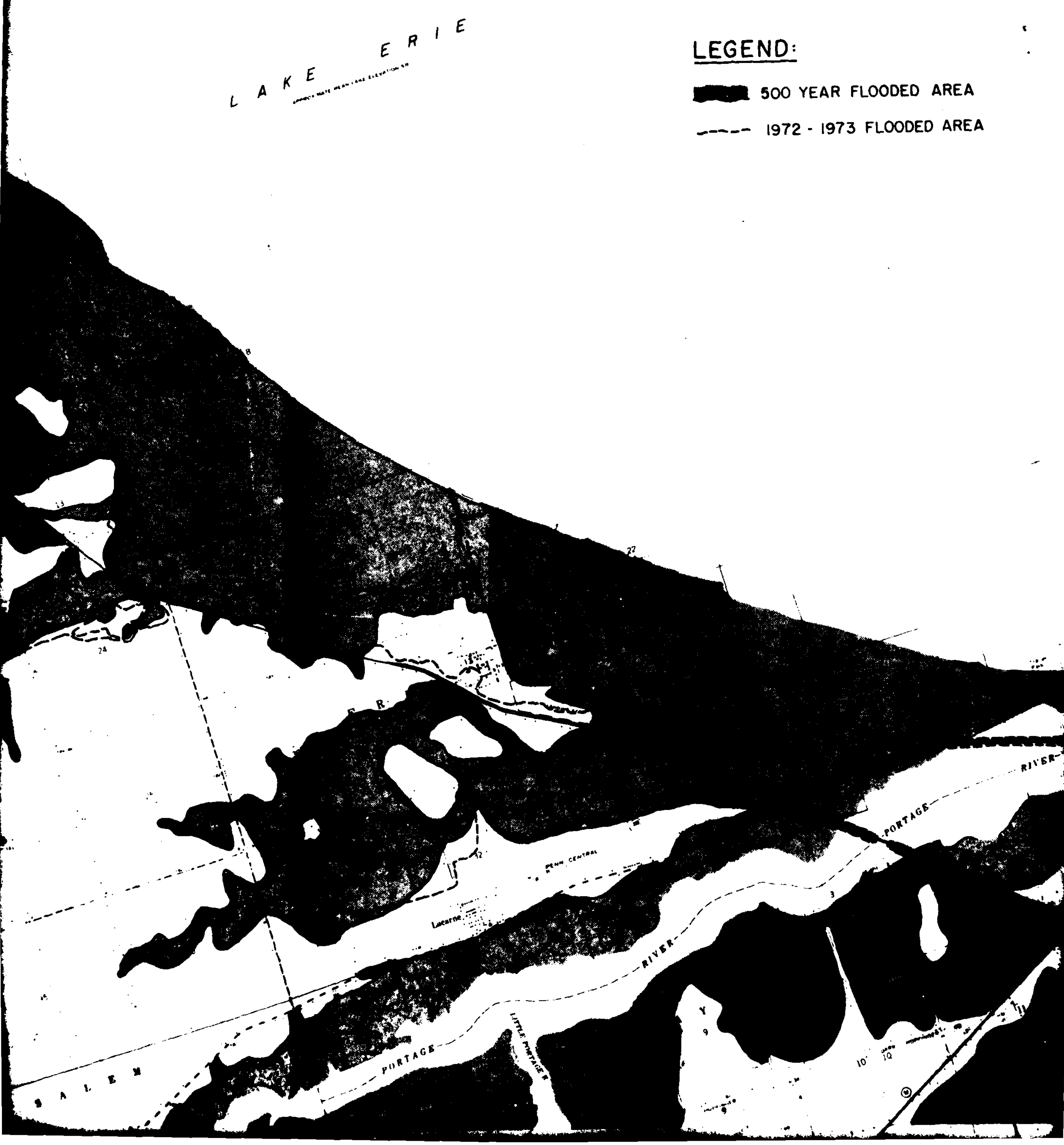
SCALE OF FEET
4000 0 4000 8000
SOURCE:
72-73 FLOOD INFORMATION FROM U.S. GEOLOGIC SURVEY
7.5 MINUTE QUADRANGLE MAPS, TITLED "FLOOD PRONE AREAS".
100 YEAR FLOOD INFORMATION FROM U.S. DEPARTMENT OF
HOUSING AND URBAN DEVELOPMENT FLOOD BOUNDARY MAPS.
J E R U S A L E M
LUCAS CO
OTTAWA CO
2


LEGEND:
500 YEAR FLOODED AREA
1972 - 1973 FLOODED AREA
LAKE ERIE
MATCH LINE A-A
JERUSALEM
SCALE OF FEET
4000 0 4000 8000
SOURCE:
72-73 FLOOD INFORMATION FROM U.S. GEOLOGIC SURVEY
7.5 MINUTE QUADRANGLE MAPS, TITLED "FLOOD PRONE AREAS".
100 YEAR FLOOD INFORMATION FROM U.S. DEPARTMENT OF
HOUSING AND URBAN DEVELOPMENT FLOOD BOUNDARY MAPS.
WESTERN LAKE ERIE SHORE STUDY
RECONNAISSANCE REPORT
FLOOD OUTLINE
U.S. ARMY ENGINEER DISTRICT BUFFALO
APRIL 1981
FIGURE


MATCH LINE A-A
(JOIN WITH FIGURE B 21.1)
LUCAS CO
OTTAWA CO
N
B E N T O N
Parker
Creek
Toussaint
Limestone
NORFOLK
AND
WESTERN

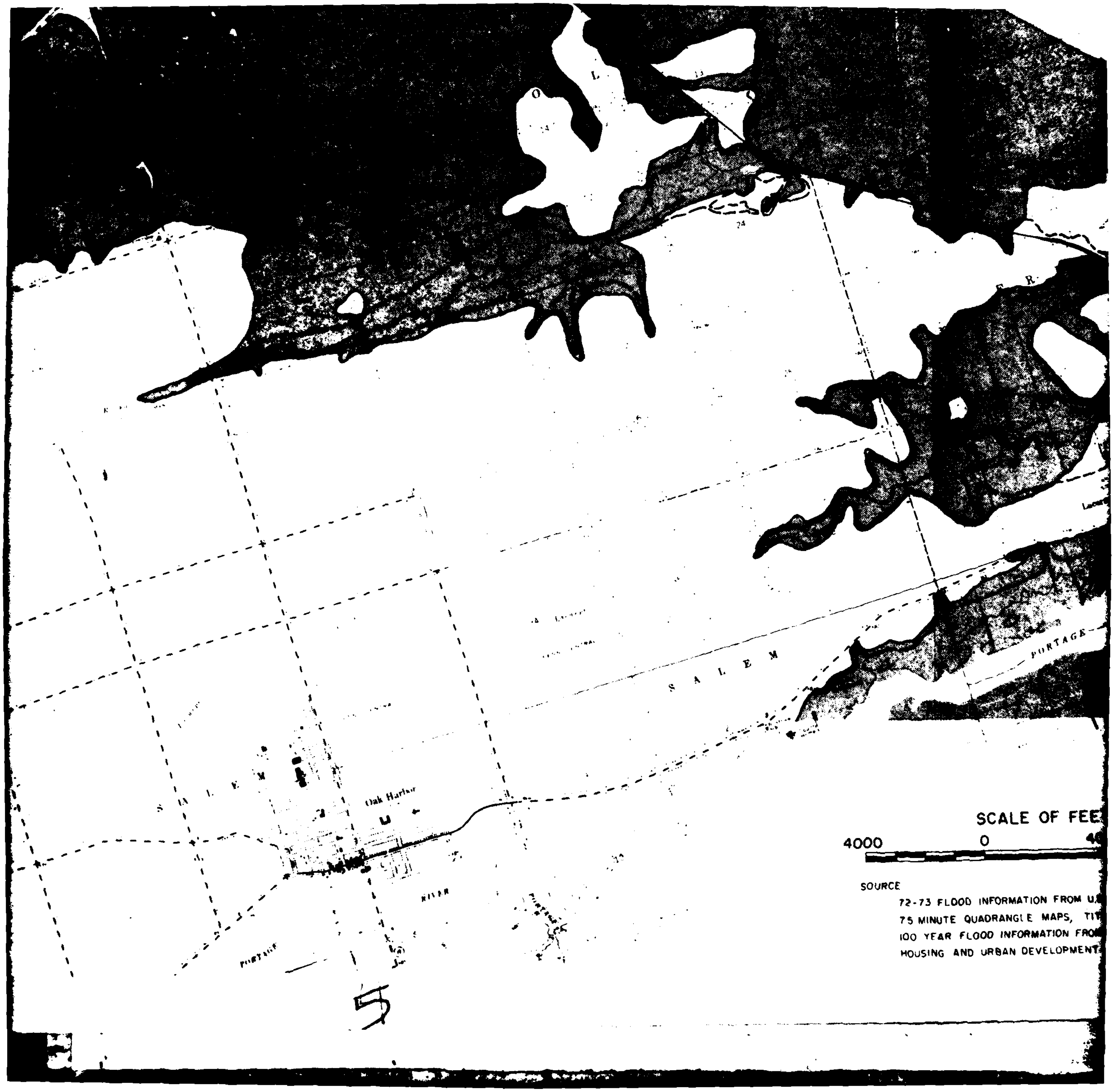
2

3


LAKE ERIE
LEGEND:
500 YEAR FLOODED AREA
1972 - 1973 FLOODED AREA
PORTAGE
RIVER
PORTAGE
RIVER
RIVER
PORTAGE
Lacarne
PENN CENTRAL
SALEM


MATCH LINE A-A
(JOIN WITH FIGURE B 21.1)
B E N T O N
Parker
Creek
Toussaint
Limestone
NORFOLK
AND
WESTERN
PENN CENTRAL
Rocky Ridge
MARTIN ROAD
Erie
2
3
9
10
11
15
16
21
22
29
33

4


S A L E M
Oak Harbor
PORTAGE
RIVER
SCALE OF FEE
4000 0
SOURCE
72-73 FLOOD INFORMATION FROM U.
7.5 MINUTE QUADRANGLE MAPS, TI
100 YEAR FLOOD INFORMATION FRO
HOUSING AND URBAN DEVELOPMENT
5

500 YEAR FLOODED AREA

1972 - 1973 FLOODED AREA

SCALE OF FEET

4000 0 4000 8000

SOURCE

72-73 FLOOD INFORMATION FROM U.S. GEOLOGIC SURVEY 7.5 MINUTE QUADRANGLE MAPS, TITLED "FLOOD PRONE AREAS"

100 YEAR FLOOD INFORMATION FROM U.S. DEPARTMENT OF HOUSING AND URBAN DEVELOPMENT FLOOD BOUNDARY MAPS

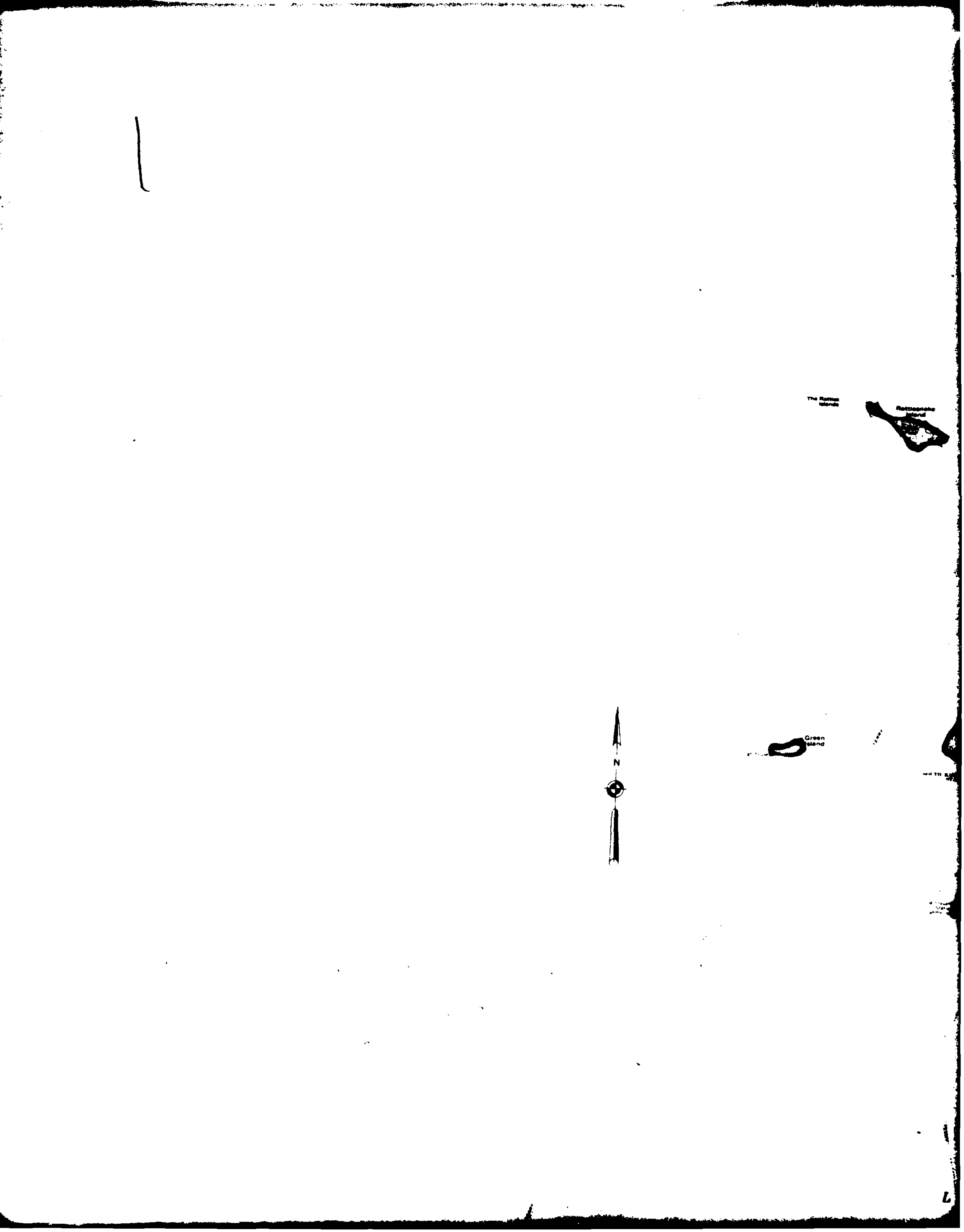
WESTERN LAKE ERIE SHORE STUDY
RECONNAISSANCE REPORT

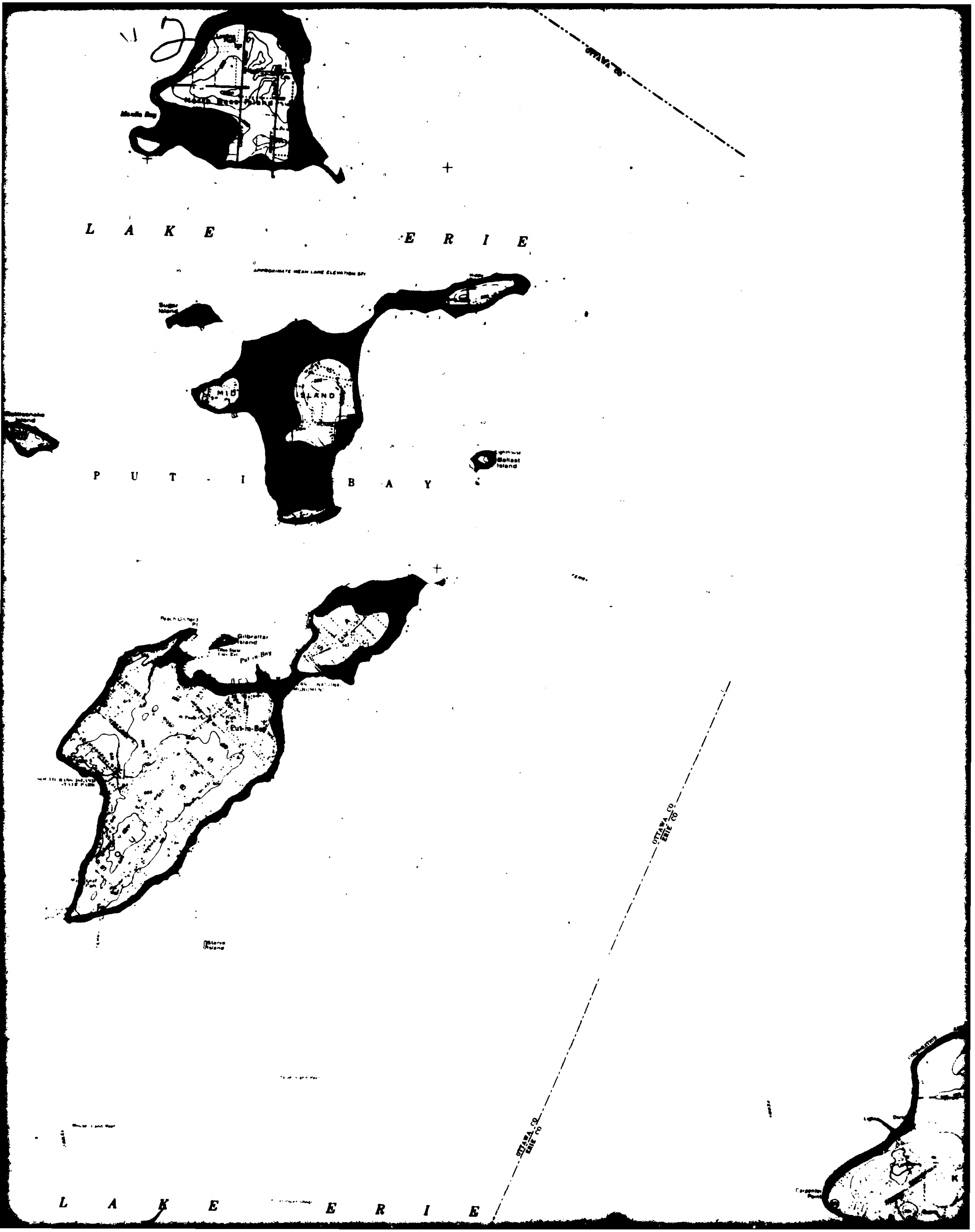
FLOOD OUTLINE

U.S. ARMY ENGINEER DISTRICT BUFFALO
APRIL 1981

FIGURE B2

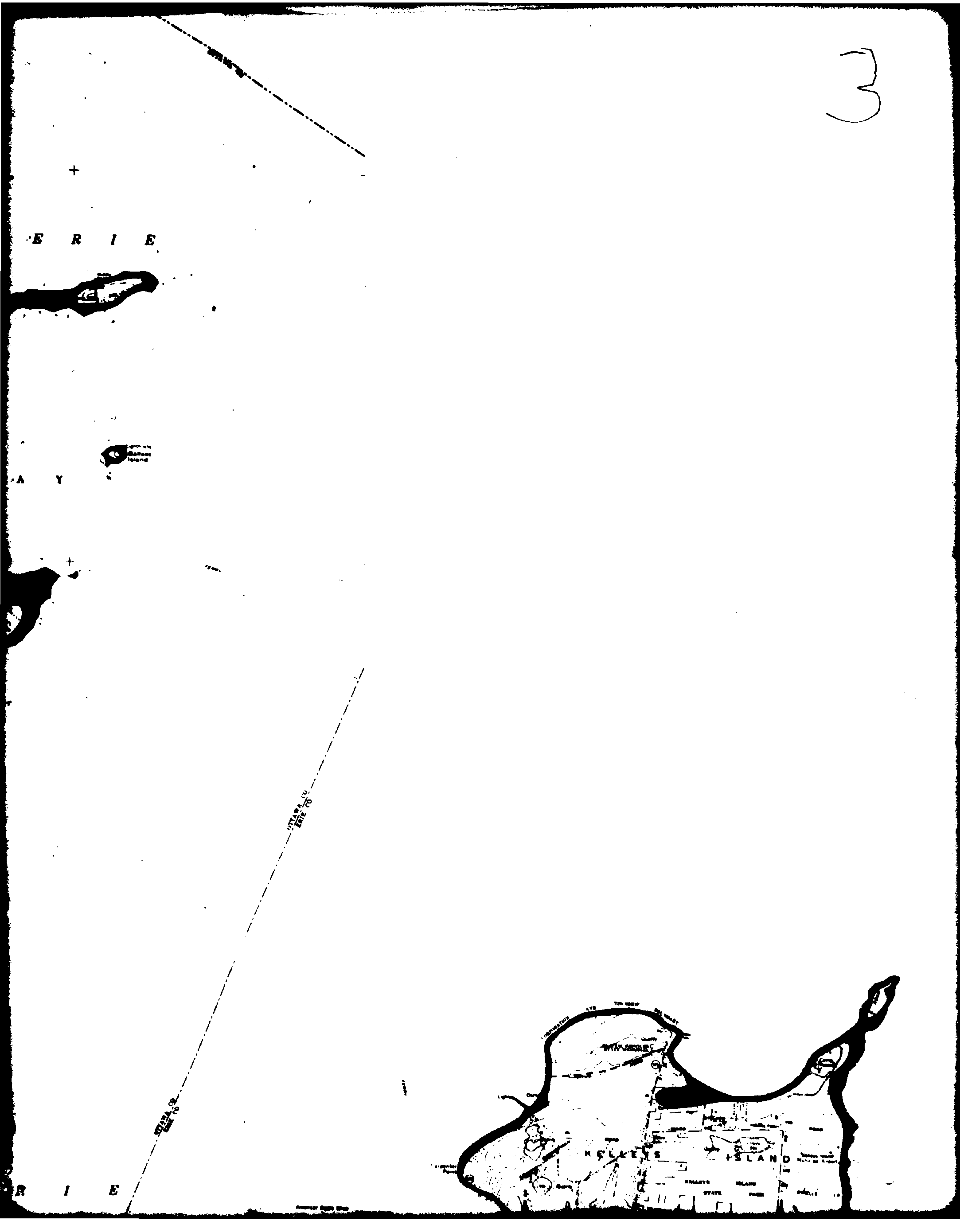
4

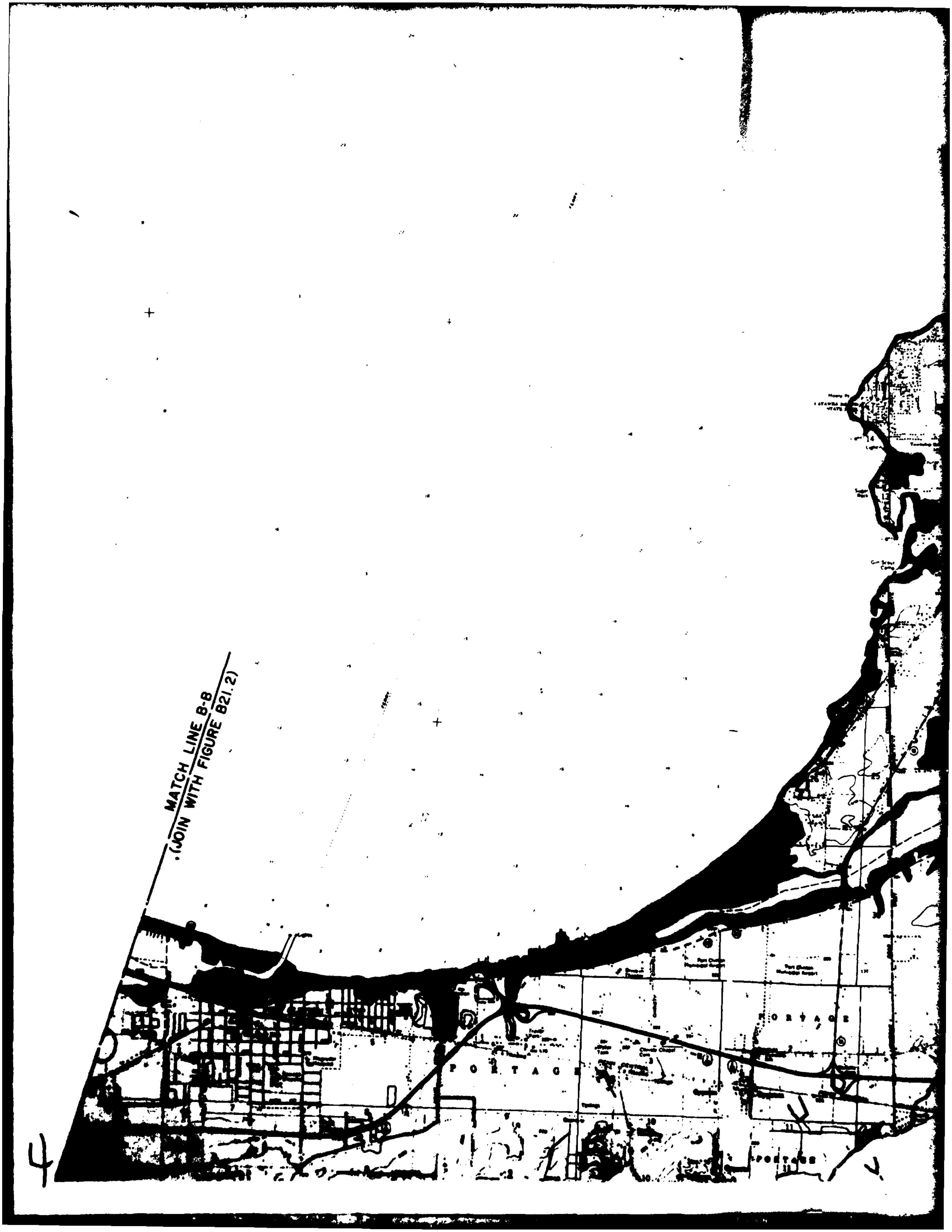

N
Green
Island



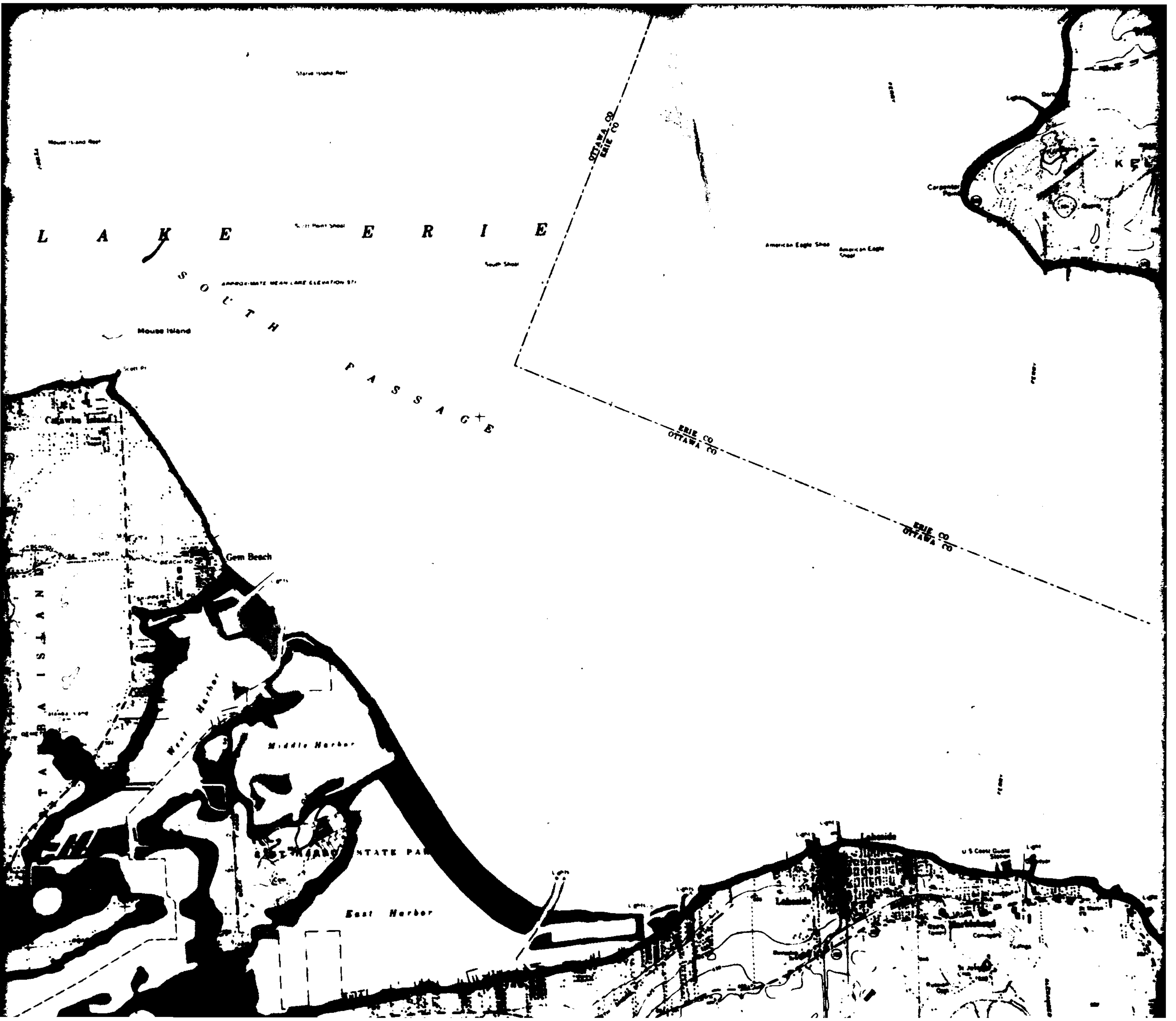
L A K E E R I E
Sugar Island
MIDDLE ISLAND
Rattlesnake Island
Lighthouse Ballast Island
P U T - I N B A Y
Peach Orchard Pt
Gilbraltar Island
Put-in-Bay
OTTAWA CO
ERIE CO
L A K E E R I E

3




MATCH LINE B-B
(JOIN WITH FIGURE B21.2)
PORTAGE
PORTAGE
PORTAGE

4



L A K E E R I E
S O U T H P A S S A G E
Mouse Island
OTTAWA CO
ERIE CO
Gem Beach
West Harbor
Middle Harbor
East Harbor
American Eagle Shoal
Lakeside
Marblehead

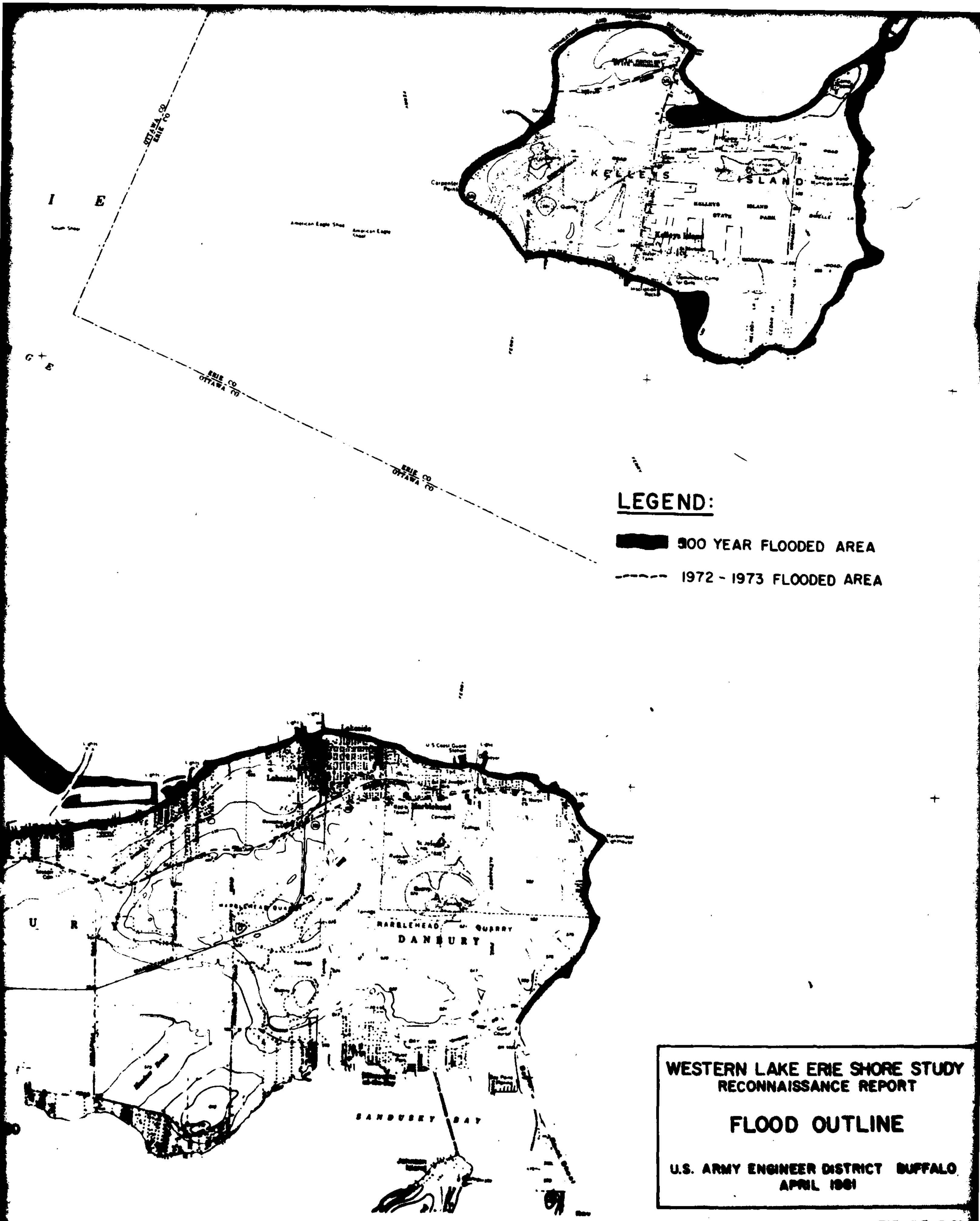

KELLEYS ISLAND
KELLEYS ISLAND STATE PARK
Carpenter Point
American Eagle Shoal
South Shoal
ERIE CO
OTTAWA CO
I E
DANBURY
MARBLEHEAD QUARRY
Lakeside
Marblehead
SANDUSKY BAY
LEGEND:
500 YEAR FLOODED AREA
1972 - 1973 FLOODED AREA
WESTERN LAKE ERIE SHORE STUDY
RECONNAISSANCE REPORT
FLOOD OUTLINE
U.S. ARMY ENGINEER DISTRICT BUFFALO
APRIL 1981

FIGURE [illegible]